

**AN INFORMATION MANUAL ON THE
URBAN TRANSPORTATION PLANNING
PROCESS FOR TECHNICAL COMMITTEES
IN SMALLER URBAN AREAS**

**SEPTEMBER 1968
NO. 19**

by

R. J. HENSEN

and

W. L. GRECCO

**Joint
Highway
Research
Project**

**PURDUE UNIVERSITY
LAFAYETTE INDIANA**



AN INFORMATION MANUAL OF THE URBAN TRANSPORTATION PLANNING PROCESS
FOR TECHNICAL COMMITTEES IN SMALLER URBAN AREAS

To: J. F. McLaughlin, Director
Joint Highway Research Project

From: H. L. Michael, Associate Director
Joint Highway Research Project

September 12, 1968

File: 3-7-1

Project: C-36-69A

The attached Progress Report on the HPR Part I research Project "Urban Transportation Planning Process" is submitted as the final report on Part I of that project. The report is titled "An Information Manual on the Urban Transportation Planning Process for Technical Committees in Smaller Urban Areas." The report has been prepared by R. J. Hensen and W. L. Grecco of our staff and is submitted for review, comment and acceptance as fulfillment of the objectives of Part I of this research.

The manual as the title describes was prepared to provide members of Technical Committees of Urban Transportation Studies with information on the several methods and techniques available to them in the conduct of such studies. The manual discusses the advantages and problems with each of the various methods and discusses practice in current studies.

The report is presented for the record.

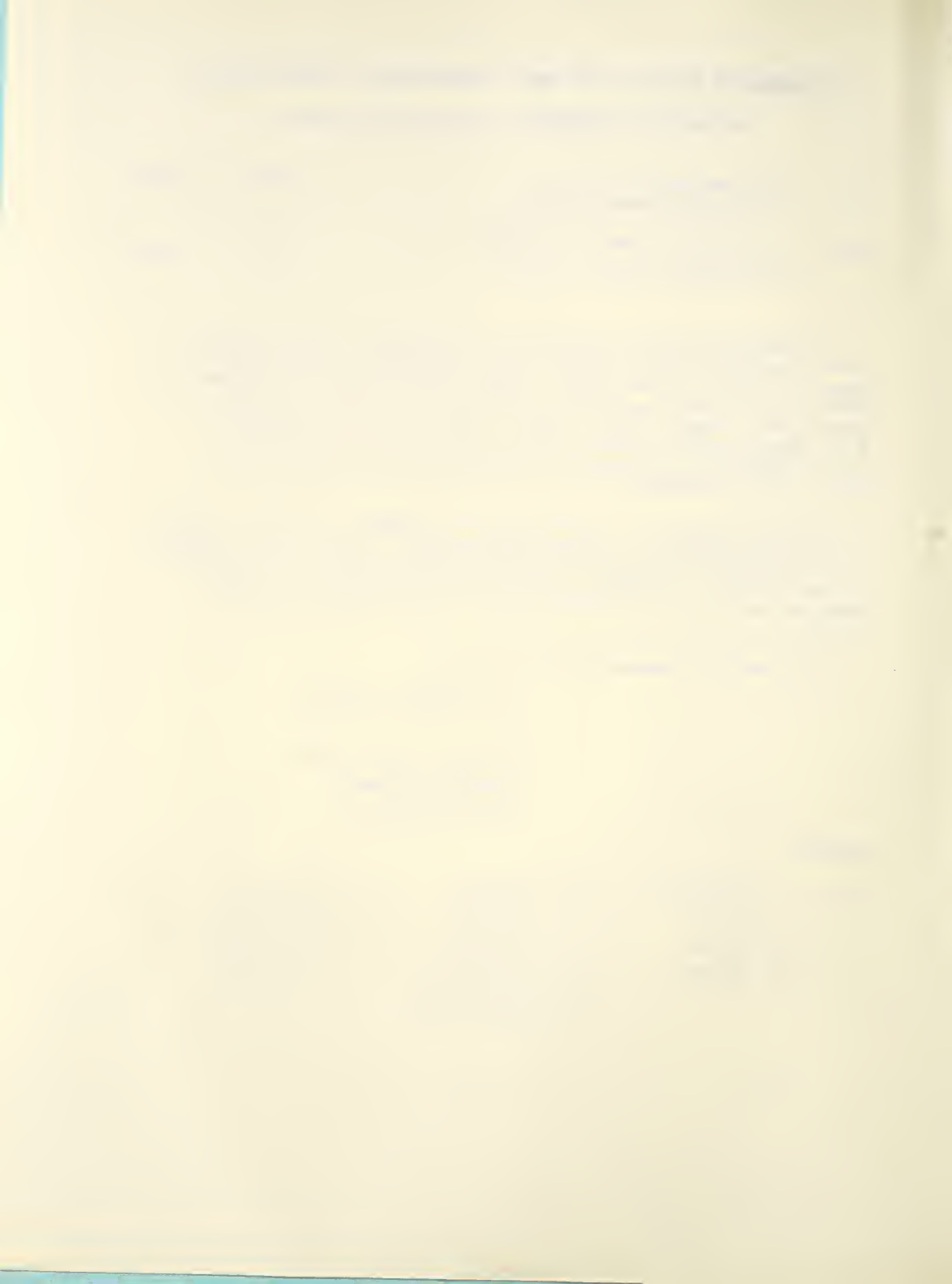
Respectfully submitted,

Harold L. Michael

Harold L. Michael
Associate Director

HLM:m2

cc: F. L. Ashbaucher	R. H. Harrell	C. F. Scholer
W. L. Dolch	J. A. Havers	M. B. Scott
W. H. Goetz	V. E. Harvey	W. T. Spencer
W. L. Grecco	G. A. Leonards	H. R. J. Walsh
G. K. Hallock	F. B. Mendenhall	K. B. Woods
M. E. Harr	R. D. Miles	E. J. Yoder
	J. C. Oppenlander	



Progress Report

AN INFORMATION MANUAL ON THE
URBAN TRANSPORTATION PLANNING PROCESS FOR
TECHNICAL COMMITTEES IN SMALLER URBAN AREAS

by

Ronald J. Hensen, Graduate Research Assistant

William L. Grecco, Research Engineer

Joint Highway Research Project

Project No. C-36-69A

File No. 3-7-1

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

and the

U.S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

Not Released for Publication

Subject to Change

Not Reviewed By
Indiana State Highway Commission
or the
Bureau of Public Roads

September 1968



ACKNOWLEDGMENT

This work was conducted by the Joint Highway Research Project of Purdue University in cooperation with the Indiana State Highway Commission and the U. S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads. The authors are indebted to Professors W. L. Michael, V. L. Anderson, and K. S. Curtis of Purdue University for their advice and editorial review.

Appreciation is expressed to the following persons whose advice and candid discussion made possible the preparation of this report: W. W. Sanders and C. C. Schimpeler, Louisville Metropolitan Comprehensive Transportation and Development Program; J. H. Cox, Indiana State Highway Commission; J. R. Leek, Illinois Division of Highways; J. L. Wright, Texas Highway Department; F. C. Burton, Colorado Department of Highways; M. R. Poole, North Carolina Highway Commission; H. R. Joyner, Barton-Ashman Associates; T. M. Pollard, Harland Bartholomew and Associates; R. E. Vogt, Vogt, Sage, and Pflum; G. A. Shunk, Allan Voorhees and Associates; and R. C. Cowdery and E. G. Muhich, Bureau of Public Roads.

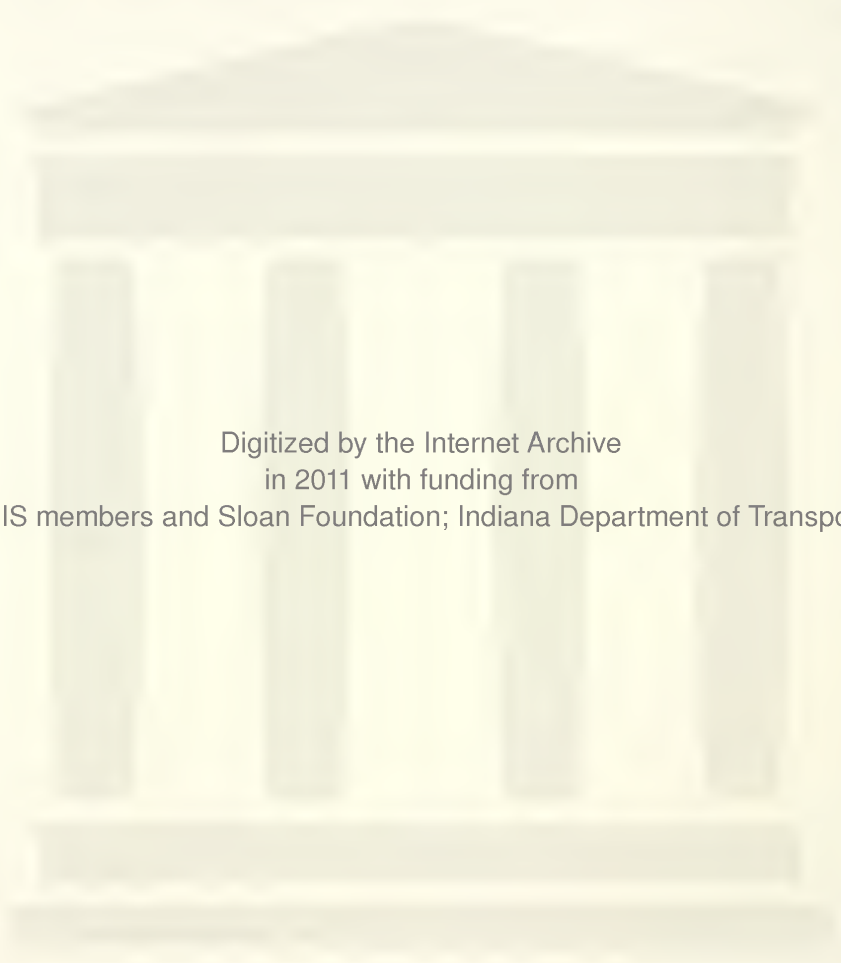
Even though the many frank discussions held with the above contributors served as the basis for many of the expressions of judgement made throughout this report, these expressions remain the sole responsibility of the authors.

PREFACE

This publication presents an information manual to assist members of Technical Committees in the smaller (30,000 to 300,000 population) urban areas in understanding the urban transportation planning process. The 1962 Federal-aid Highway Act stipulates that an urban area greater than 50,000 population must have an adequate transportation plan based on a continuing analysis of travel demands before Federal Aid can be allocated to highways within the area. Some smaller urban areas have found it difficult to attract sufficient numbers of technically trained personnel to initiate a meaningful transportation study.

The manual describes the transportation planning process that usually is initiated by a committee of local agency professionals, many of whom are generally unfamiliar with transportation planning. Such a committee typically acts under the direction of a Policy Committee composed of elected and appointed officials of the political jurisdictions within the urban area.

The purposes and objectives of urban transportation planning are developed. The preparation of a study design is discussed. A sample study design is presented. The operational procedures are described in six phases: inventory, analysis, forecast, system testing, plan development, and continuing reappraisal. Alternative technical procedures available for the various phases are described and the particular advantages of each are discussed and are reflected in technical staff requirements.



Digitized by the Internet Archive
in 2011 with funding from
LYRASIS members and Sloan Foundation; Indiana Department of Transportation

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENT.	ii
PREFACE.	iii
LIST OF TABLES	vii
LIST OF FIGURES.	viii
INTRODUCTION	1
CHAPTER I HISTORICAL DEVELOPMENT OF TRANSPORTATION PLANNING.	4
The Role of the Congress.	6
The Role of the Bureau of Public Roads.	7
The Role of the State Highway Departments	8
The Role of the Professional Consultant	9
The Role of the Local Agencies.	10
The Net Effect.	12
CHAPTER II THE CONCEPT OF PLANNING	14
The Transportation System	15
Transportation Planning	17
CHAPTER III ORGANIZATION OF THE STUDY.	21
Initial Organization.	22
Defining the Area	23
The Prospectus.	23
The Agreement	24
The Committees.	24
The Staff	27
CHAPTER IV THE STUDY DESIGN.	34
The Flow Diagram.	36
Resource Estimates.	41
CHAPTER V THE INVENTORY.	43
The Required Data	45
Procedures.	46
Data Coding System.	47
Enumeration of the Data	51
Aggregating the Trip Data	53
Sample Size and Accuracy Checks	60
The Data Set.	62
CHAPTER VI ANALYSIS AND MODEL DEVELOPMENT.	74
The Economic Base	75

TABLE OF CONTENTS (continued)

	Page
Population	65
Land Use Patterns	68
Transportation Demand	71
Generation	72
Modal Split	7
Distribution	77
Assignment	79
Political Control and Financial Limitations	87
CHAPTER VII COMMUNITY DEVELOPMENT CRITERIA	89
Recognition of the Problem	89
Current Approaches	91
The Smaller Urban Area	95
CHAPTER VIII FORECASTING	99
The Forecast	100
Economic Growth of the Area	100
Distribution of the Growth	101
The Travel Demand	103
Financial Forecast	104
CHAPTER IX FUTURE SYSTEM ALTERNATIVES	109
Criteria Establishment	109
Effective System Evaluations	109
Presenting the Alternatives	110
CHAPTER X PLAN DEVELOPMENT	112
Street System Improvements	112
Transit System Improvements	113
Terminal Improvements	114
Land Use Controls	115
Programming the Plan	117
Publication	117
CHAPTER XI THE CONTINUING PROCESS	119
Organization	119
Council of Governments	120
Agreements	120
Committees	120
Staffs	121
Operation	121
Surveillance	122
Reappraisal	123
Service and Plan Implementation	123
Procedural Development	124

TABLE OF CONTENTS (continued)

	Page
Documentation	124
LIST OF REFERENCES	125
APPENDIX A	130
APPENDIX B	135

LIST OF TABLES

TABLE	Page
1. Sample Daily Person-trip Table.	61
2. Sample Land Use Growth Ratios	70
3. Average Person-trips per Household.	73

LIST OF FIGURES

FIGURE	Page
1. Alternate Study Staffing Plans.	24
2. The Transportation Study Process.	3
3. Sample Street Coding System	40
4. Sample Inventory Zones.	52
5. Enumeration of the Interview Data	66
6. Sample Traffic Zone Coding.	70
7. Economic Analysis Flow Diagram.	7
8. Sample Trip Length Frequency Curves	80
9. Community Travel Time Standards	97

Appendix
Figure

A-1. Sample Activity Sequence Diagram.	131
--	-----

INFORMATION MANUAL ON THE
URBAN TRANSPORTATION PLANNING PROCESS
FOR TECHNICAL COMMITTEES OF SMALLER URBAN AREAS

INTRODUCTION

The daily transportation of people and goods within urbanized areas is presently being studied in over two hundred urbanized areas throughout the country. The scope of these urban transportation studies, hereafter referred to as Studies, are concerned with identifying the need for transportation systems and the coordination of these needs with an overall program of improvement of the urban environment. This nationwide effort has been stimulated by an increasing Congressional awareness of the detrimental effects of inadequate urban transportation systems.

The philosophy of comprehensive urban transportation planning began developing in the years immediately following the Second World War (House Document #379, 1944). By 1954, initial acceptance as an art was exhibited with the forming of the National Committee on Urban Transportation (NCUT). This committee drew from the experiences of many of the country's leading authorities in city planning, transit operation, traffic engineering, and highway planning. These

experiences were combined and published in a transportation planning guide and a series of seventeen procedural manuals (NCUT, 1958).

The work of NCUT was a major step forward in the then infant stages of urban transportation planning. It was followed by extensive research and study represented in the work of transportation studies initiated in large urban areas such as Detroit, Chicago, Pittsburgh, Philadelphia, and New York City (Zettel and Carll, 1962).

The underlying motivation for the concentrated efforts of NCUT and the large urban area Studies noted above was provided by the 1944 Federal Highway Act's creation of the Interstate Highway System with its proposed 6000 miles of urban extensions and connections. With few exceptions, the research work that followed the Act was concentrated on solving the transportation problems of the major cities in which most of these Interstate links would be located. Little consideration was given the smaller urban areas because their problems seemed trivial by comparison (Cowdery, 1962). However, the 1962 Federal Highway Act recognized a need for coordinated planning in smaller urbanized areas as well as larger ones, and placed a requirement of a formalized planning effort in all urbanized areas over 50,000 population as a prerequisite to Federal Aid participation in highway improvement. This restriction of funds within the revenue-poor smaller urbanized areas has been successful in creating

a desire to develop adequate planning efforts; but an acute shortage of trained transportation planners and a lack of research into the level of sophistication required has hampered the initiation of meaningful Studies (Gakenheimer, 1964).

Recent research and the experiences of those smaller urbanized areas that have meaningful Studies in progress are contributing to the development of a set of procedures that, hopefully, will be both adequate and suitable for implementation by personnel with limited transportation planning backgrounds. It is the purpose of this report to describe the experiences of completed Studies; and to discuss the problems involved in designing and administering Studies in smaller urbanized areas. No attempt has been made to be rigorously inclusive of all Study elements in the discussions. This report is not intended as a handbook of procedures, but rather an informative description of the efforts and commitments required to initiate a Study. For purposes of this report, a smaller urbanized area is defined as being in the range of 30,000 to 300,000 population.

CHAPTER I. HISTORICAL DEVELOPMENT OF TRANSPORTATION PLANNING

The Role of the Congress

The transportation of persons and goods as a major form of communication plays a critical role in the economic development of a region. Historically the initiation of highway planning efforts has been based on a recognition that an inadequate road system is a major deterrent to economic growth.

In the early 1900's the Congress, recognizing a need for improvement in postal communication, instituted a Federal-Aid Program to assist the States in constructing an improved highway system. Along with this aid came regulations requiring the establishment of a State highway system and a highway department within each State.

By 1934, the Congress recognized that the Federal Aid was being spent to correct many deficiencies that were being created by a lack of planning. This prompted them to revise the law to allow the States to use up to one and one-half percent of the Federal funds for planning and research efforts. It represented the first major attempt to legislate the transportation planning process.

In the 1940's with the migration of the populus to the cities came a revision of the Federal-Aid Highway Program to

allow participation in the construction of urban extensions of the rural highway system. It also created a 40,000 mile urban and rural Interstate Highway System. The 1956 Highway Act established a trust fund of highway user tax monies to finance the Interstate System on a ninety-ten Federal-State participation basis.

By 1962 the Congress again recognized that a lack of planning was causing problems in the integration of the Federal Aid Highway system into the urban areas. Thus they established a requirement that urbanized areas with populations greater than 50,000 must have a continuing, comprehensive and cooperative transportation planning study of a nature sufficient to define their future transportation needs before Federal Aid funds could be used for construction. This was by far the most vital step in the Federal Government's role in transportation planning and reflected their increased concern for the future of the urbanized areas. Congressional concern had been exhibited earlier in the 1954 Federal Housing Act's section "701" which provided two-thirds of the cost of preparing comprehensive plans for urbanized areas greater than 50,000 population. However, the loss of highway construction funds was a direct affront to revenue-poor smaller urbanized areas that have come to depend on the State highways as major traffic arteries.

The Role of the Bureau of Public Roads

Throughout the history of Federal Aid participation in highway programs, the role of the Bureau of Public Roads (BPR) as administrator of the Federal-Aid funds has been one of both inspector and adviser. The Congress requires that it maintain a constant vigilance on the Federal pocketbook. Consequently, in its role of inspector it has been required to define criteria on which fund approvals must be based. A shortage of qualified personnel and a general apathy to problems of proper planning, design, and construction by many State highway departments (SHD) has forced BPR to establish a multitude of such criteria. In a few cases, the SHDs have come to depend on BPR for a complete set of procedures for every situation, using them as a substitute for their own lack of technical background. Others have attempted to reject all forms of BPR procedures, suggesting that their own methods are superior. Both extremes have only added to the confusion of this young art and have at times handicapped the advancement of highway transportation planning. Fortunately, many of the SHDs have avoided such radical stands, and have been extremely helpful in the establishment of adequate procedures.

In urban transportation planning BPR has been a major force both in definition of standard procedures and in the promotion of research. It has been deeply involved in the training of transportation study personnel, has participated

actively in the NCUT program, and has sponsored many research studies concerned with developing new planning concepts. The 1962 Highway Act resulted in BPR's issuing definitions of what constitutes a continuing, comprehensive, and cooperative transportation study (BPR, 1963). These definitions, developed from the experiences of the larger transportation studies, were meant to include the minimum elements that should be investigated as to their effect on transportation. Because of the extreme shortage of personnel trained in transportation planning, BPR has attempted to aid urban areas by developing standardized procedures to complement the NCUT manuals and by organizing a set of electronic computer programs that accomplish many of the required computations. These procedures and programs have been a great aid to the technicians who have become involved in a study process.

BPR has had more combined experience than any other agency in urban transportation planning. However, its responsibilities for developing computer programs and techniques required in the collection of data required at the outset of a Study has caused a seeming overemphasis of this phase. Thus, some of the personnel charged with the actual completion of Studies have become so involved in satisfying the acceptance criteria of BPR that they have tended to develop a very biased perspective of the total planning process. A lack of recognition that computer programs are limited to the accuracy of assumptions on which they are based and that

mathematical tools are only aids to professional decision making are two of the major problems.

The Role of the State Highway Departments

Through their involvement with the Federal-Aid requirements for planning, the SHDs have been concerned with estimating demands for highway travel for over forty years. However, they first became concerned with urban travel demands following the 1944 Federal Highway Act. In the 1940's most SHDs were concerned with providing adequate highways around urban areas. Rural-dominated legislatures emphasized the construction of improved intercity highways. Consequently, SHD planning tended to ignore the effects of the highway system on the urban environment.

As Federal-Aid legislation began to require a more comprehensive approach to the role of the highway within the urban areas, the SHDs found themselves inadequately staffed to perform the required planning. A few SHDs were able to develop an adequate staff and proceeded to plan for the urban area demands. Others contracted with professional consultants to complete the required planning. In most cases, however, the decision regarding highway improvements were made with little regard for their resulting effects on adjacent land uses. In rural areas this practice had caused negligible detriment. However, within the urban area, the uses and intensities of development were greatly affected by improvements. In some cases limited access freeways bisected

well defined neighborhoods, resulting in a rapid deterioration of the area.

The citizens of the urban areas, traditionally quite satisfied to have SHDs solve the transportation problems, began to realize that solving one problem only created another. Thus it became apparent that the SHDs alone were not in a position to make all of the planning decisions, even though they may have the responsibility for construction of the facilities. This realization was in part responsible for the 1962 Highway Act planning requirements. Following that act, most SHDs attempted to establish cooperative Studies within each of the urban areas. However, in many instances they found that the local agencies within the urbanized areas were financially unable to provide a cooperative effort. This combined with the continued shortage of technically trained personnel led to planning programs which consisted of following the minimal criteria procedures established by BPR, often by contracting with a professional consultant to complete the necessary Study requirements. In neither of these cases was a satisfactory planning process established.

The Role of the Professional Consultant

The lack of personnel trained in transportation planning and the need to satisfy Federal-Aid requirements placed the professional transportation planning consultant in a difficult position. With the increased emphasis on planning

his services became extremely valuable and in great demand. However, uncertainty as to the value of planning and a lack of knowledge as to what constituted adequate procedures created many problems. In a number of urban areas a consultant was retained to perform the entire Study. In cases where BPR suggested guidelines were rigidly followed, the consultant became a glorified source of manpower with a costly built-in overhead. His professional role was limited to those few cases not covered by a procedure. On the other hand, in those Studies where little or no control was placed on the consultant's procedures, there were too many cases of contract completions with sketchy or even totally absent documentation of procedures. This resulted in a number of Studies being unable to apply the results or to update the initial work to reflect changes. In neither of these cases was the professional counsel of the consultant being properly utilized. In fact, by placing him in a position of having to provide contracting services rather than consulting services, the Studies encouraged legal rather than professional results.

The Role of the Local Agencies

Planning efforts in urban areas have been subjected to many cycles of enthusiastic encouragement and total neglect. Lack of a consistent attitude and responsible action coupled with an extremely inadequate source of local taxes has forced the Federal Government to initiate a number of programs to

encourage the orderly development of urban areas.

In the past, the role of the transportation system in the development of urban areas has been ignored or at least neglected, generally being thought of as a necessary evil. City subdivisions were designed by surveyors with little regard for the street other than as land access and utility easement. The action of the Federal Housing Administration (FHA) in the 1930s first established guidelines to insure a more positive relationship between the streets and the land use. Arterial streets, supposedly for the movement of traffic, were established with little knowledge of the actual demand.

Following World War II, the recognition of these above mentioned problems by the Congress provided the incentive necessary to initiate a more comprehensive approach to the role of urban transportation. Studies initiated in Cleveland and Detroit in the early 1950's were among the first efforts. However, the smaller urban areas were not so easily convinced. On one hand they lacked the technically competent personnel, and on the other hand their attitudes were that the major planning problem was primarily a question of financing any improvements.

The 1962 Highway Act placed the smaller urban area in a bind. They depend almost entirely on State highways as their arterial systems. Thus they were forced to develop a planning process if they were to continue receiving Federal

and State construction improvements. In many States the SHD initiated the planning effort, asking the local agencies to participate where possible. Such participation requires some basic level of knowledge and competence if it is to be anything more than window dressing. With BPR continuing to be more and more critical of the lack of participation, the local agencies have had to develop at least a skeleton staff of urban planners. This has been a slow process, but there is some evidence that progress is being made. For example, the city council members and county commissioners are learning that planners can provide information on the consequences of zoning changes, thus giving them a stronger argument against an adverse request.

The overall effect of the required local participation in planning has led to a basic understanding of its value and this in turn is causing an increased effort to establish land use planning and traffic engineering as a part of the public works actions of local government.

The Net Effect

In considering the overall history of transportation planning to the small urban areas, one point appears to be most evident. Because of the financial burden of the local community and the relative abundance of planning and construction money for highway improvements, there has been a tendency to develop a transportation improvement program with little regard for the total community needs. Thus, an

inadequate supply of parking facilities causes a decline in central business district shopping, lack of adequate and economical transit service causes a marked reduction in the effectiveness of public transportation, and uncoordinated zoning allows strip commercial development along major transportation routes. The net effect of such uncoordinated efforts has been an urban growth pattern that is unacceptable to the people.

CHAPTER II. THE CONCEPT OF PLANNING

Hatt and Reiss (1951) define the planning process as a series of value decisions, including:

1. What kind of community is wanted;
2. What kind is available for a given set of resources;
and
3. What is the best method of achieving the reality
of that community.

They suggest that planning is directed toward the isolation of socially acceptable group goals and the establishment of means for implementing these goals. Ashman (1963) suggests that planning is essentially political, in that the planner attempts to affect social goals within an existing governmental framework. This framework is defined by a series of policies which allow the formation of acceptable standards of adequacy.

The mass migration of people to the cities has swung the political emphasis to the problems of the urban areas. Currently a multitude of Federally financed projects are aimed at improving the urban environment. Included are loans and grants to assist planning or construction of hospitals, educational buildings, airports, water supply, and distribution facilities, urban renewal, mass transit systems, and

highway facilities. Most recently the demonstration cities program has been added (Office of the Vice President, 1967). Because of the interrelationship between many of these projects such as freeway right of way requirements and urban renewal efforts, it is necessary to develop a formal, comprehensive planning program to insure that the projects complement each other's goals and provide a common basis for implementation.

The Transportation System

In the smaller urbanized areas, state highway generally form the backbone of the major street system. The local agencies depend on the financial backing of the SHD. Many of these areas do not have the services of a professional traffic engineer and depend on the SHDs to aid the city engineer in solving local traffic congestion. The Congress has recently enacted a program entitled "Traffic Operation Program to Increase Capacity and Safety" (T.O.P.I.C.S.), which allows the SHD to participate in traffic flow improvement programs for urban streets not designated as a part of the State highway system. Such a program must be properly coordinated so as to provide for anticipated future growth.

Although the effects of public transportation, such as buses, have a very minimal effect on the street system requirement in smaller urban areas, it is necessary to consider the role of transit as a community service to the young, the old, and the impoverished (Wynn and Levinson, 1967). Here

again the Federal role in mass transportation is causing an effort to redevelop transit in a role similar to that of public health. At any rate, the transit system requires the street system as an operating network and as such should be an important part of the decision process for the planning of the future street system.

Another important aspect of the transportation study is the pattern of commercial freight movement within the urban area. Railroads in the past created artificial barriers which often caused a detrimental growth pattern within communities. As the role of the railroads changes and as their operations require additions and modifications to their physical plants, it is necessary that these changes be anticipated and coordinated with the urban planning process.

The location of truck terminals and the intraurban movement of trucks influences urban travel demand. Since most truck traffic is limited to the major street system, the minimization of trip numbers and trip lengths by coordinating terminal locations can have a marked effect on the performance of the street system.

The most recent influence on the transportation system is the air terminal and its accompanying highway traffic generation and land use effects. The improvement of the short-haul planes and the ever increasing demand for passenger and air freight service will undoubtedly create justification for air terminal expansion programs of a magnitude

similar to the Interstate Highway program. The interstate nature of air traffic suggests that such a program will be heavily financed by the Federal Government and as such will necessarily become a part of the comprehensive planning program.

Transportation Planning

Transportation planning serves two major objectives. Short range planning attempts to define the existing travel demands, to establish standards of adequacy of the existing transportation system, and to define a tolerable level of service for each of the facilities in use. By considering these aspects of the system, the intolerable deficiencies can be determined and a program initiated to eliminate or at least reduce them. In long range planning the objective is to anticipate growth potential and develop a transportation plan that will serve and foster such growth. It requires that travel demands be forecast for a commonly accepted planning horizon year.

The present concept of transportation planning in the smaller cities can be described in six basic phases. The first phase consists of observing the current system and is usually referred to as an inventory. Its purpose is to provide quantitative measures of the current travel demands of the people and goods within the urbanized area. Also measured are land use patterns and the accompanying characteristics of population, employment, and other specific data

that experience and continued research have shown to be influential factors in predicting the demand for intra-urban travel.

The second phase is the development of techniques for associating trip making with the measures of land utilization. This is referred to as the analysis (synthesis) step and is concerned with developing mathematical relationships between travel and the potential for such movements in terms of residential populations, places of employment and shopping, and accompanying factors which control trip making, such as auto availability and adequacy of the street system. These mathematical relationships are called "models" in that they are an attempt to model the real transportation system. There are models which describe the demand for travel called "generation" or "production-attraction" models; there are "distribution" models that describe the trip origin-destination pattern; and there are models that attempt to describe the street routes used to accomplish the trips, which are called "assignment" models.

The third phase in the process is an evaluation of the economic growth potential of the urban area and the projection of requirements for this potential in terms of population and employment increases and their necessary land utilization. These estimates along with other factors that were shown to have a significant influence on travel patterns in the model development are then used to predict the travel

demands that will accompany the economic growth of the area.

In the fourth phase, the future demand for travel reflected by the growth forecast is related to the anticipated growth patterns of the area and the existing capabilities of the transportation system. Alternate transportation improvements are tested and technically feasible alternatives are prepared.

The fifth phase consists of selecting the system alternate which best reflects the value of transportation in light of total community needs. Such a selecting process requires that the goals and objectives of the community needs for health, safety, education and general well-being be well defined. Establishing such a defined scale should be a major part of the study if it is to fulfill its major objectives. Once the plan is selected, a priority program of improvements is established in light of financial abilities and the estimated growth rate of the area.

The sixth phase in the planning process is concerned with a continuing analysis of travel demands and land utilization patterns. This allows the study to take advantage of additional data not available during the initial phases of the Study. Thus, trends in the factors used to forecast the future demand can be determined and a periodic comparison made between the proposed system and the demand. From these comparisons it is then possible to recommend additions and/or modifications to the transportation system selected for implementation.

The six phases described above comprise the general form of the transportation planning process. It should be emphasized that this is a process as opposed to an unyielding plan. As such, it is a part of the overall community planning effort and must necessarily be integrated with the total planning effort if it is to achieve its goal of providing a continued community service.

CHAPTER III. ORGANIZATION OF THE STUDY

The initial steps of the organization of the Study must be concerned with defining the geographic limits of the Study (political jurisdictions that will be involved), and the preparation of a prospectus of the scope of the Study. The decisions involved in the initial steps should reflect the local community attitude toward the general philosophy of future planning. If the local jurisdictions can be convinced to place a high priority on a formal program of future planning, the Study should be organized to complement such a program. Ideally programs such as urban renewal, public transit, and general comprehensive planning should be reflected in the scope of the Study. Joint efforts in data collection, coordination of estimates of future community growth patterns, and the establishment of a common scale of community goals for developing priorities for capital improvements can be the major benefits of such cooperation.

Currently there are a number of Federal-Aid programs for urban areas that directly complement transportation planning. Section 701 of the 1954 Federal Housing Act, as amended, provides between two-thirds and three-quarters of the cost of developing a comprehensive land use forecast for the urban area. The Federal Mass Transit Act of 1964 provides loans

and grants to establish or stimulate public transit. Both of these programs are administered by the Federal Department of Housing and Urban Development (HUD). If the benefits of these and other programs are to be maximized, there must be coordination with transportation system planning.

Initial Organization

The SHDs, as agents of the Federal-Aid funds, often are in a position to assume a dominant role in the initiation of the Study. They have a formal mechanism for requesting counsel and guidance from BPR, are in a good position to act as liaison between the local agencies to be involved and are most familiar with problems encountered by previously performed studies. However, there is a danger in their assuming such a role. Local communities have a history of letting highway departments make future plans for their area. However, they also have a history of ignoring such plans. Thus a successful Study that will provide a sound basis for a feasible improvement program must include the efforts of all agencies that will be involved in seeing that the program is implemented.

Defining the Area

The establishment of the geographic limits of the Study can usually be accomplished by a group of representatives from the local jurisdiction within the urbanized areas (cities, counties, townships, etc.), along with the SHD and BPR. Economics will necessarily limit the size that

realistically can be considered. However, the general factors to be considered are types and intensity of urban land use and the daily travel to and from the central city. These factors greatly influence the activity pattern. The area thus defined has been referred to as a "commuter shed" for some of the large urban areas (Zettel and Carll, 1962). The Study area, hereafter referred to as the Area, should include all land most likely to have a predominantly urban, as opposed to rural, activity pattern within the planning period, most commonly twenty years. The use of county and township boundaries has been satisfactory in some cases. In others the rural oriented commissioners have been successful in avoiding the inclusion of what they consider prime farm land. Such a boundary can only find definition in an arbitrated committee decision based on the best available data.

The Prospectus

In order to define the role of each of the agencies to be concerned with the Study, it is necessary to prepare a prospectus (Bolyard, 1965). This document serves as a sales pitch to the agency administrators who must take an active part in order to make the Study effective. It should describe the purpose and the scope of the Study, the geographical limits of the Area, and the political jurisdictions included. It should give a general outline of the Study process, an estimated time schedule for completion of the various phases, and a general estimate of the costs to be incurred and how

these costs are to be shared by the participating agencies. It should explain the need for the Study and why local agency participation (including financial) is necessary. It should not be necessary to include details of Study operation, as such information will usually benefit only those persons already aware of both the need for, and the operation of, a transportation planning study. Finally, the prospectus should describe the establishment of a series of committees to guide the Study and a suggested means of providing the necessary personnel to staff the operation.

The Agreement

The Federal Aid requirements of the 1962 Highway Act require that each of the political jurisdictions involved in the Study, enter into a formal written agreement to participate (BPR, 1967a). The form of these documents, sometimes called "memorandums of agreement" will vary from state to state, but in each case the intent is to bind all parties to a cooperative planning effort.

The Committees

The Study, in order to be truly a cooperative effort, must take its direction from a committee composed of elected and appointed officials representing each of the participating agencies. Such a committee, commonly referred to as a "policy" committee, has the responsibility of establishing the format for the overall program, reviewing the completed work of the Study, enlisting the services of professional

consultants, and presenting the proposed plans to the public. An organization structure recently created which serves the needs of such a policy committee is the Council of Governments (Hanson, 1966). Such a council is in a position to coordinate all types of urban improvement programs and is well aware of the problems involved in cooperative planning efforts. The requirements of a transportation study policy committee have been a major part of the justification for the creation of a number of such councils.

The policy committee members, primarily agency administrators such as mayors and commissioners, are usually not aware of the technical aspects of the Study, and their time is quite limited by the demands of their own agencies. For these reasons, a committee of technically trained persons should be appointed by them. Its membership most commonly is comprised of city and county engineers, traffic engineers, highway engineers, city planners, and representatives of the divisions offices of BPR and HUD. This so-called "technical" committee is usually given the responsibility of defining and reviewing the individual phases of the Study. It also performs the function of educating the administrators and other technicians in the members' own agencies. The committee's continual appraisal of the work performed provides an assurance to each agency that its interests are being considered and weighed in the decision process. Persons selected for membership on the technical committee should be

made aware of the educational process that they face. Their ability to properly guide the Study operations and to inform the local community of the value of the planning process will have a strong influence on the success of the plan implementation.

If the Study is performed by a staff comprised of personnel contributed by the cooperating agencies, the technical committee generally will be expected to contribute a great deal of guidance in the selection of alternative procedures and in reviewing the work of the staff. A strong committee will greatly assist the study process by providing positive leadership to the staff personnel. If, on the other hand, a consultant is retained to perform the staff operations, the technical committee's role is quite different. Initially it is asked to advise the policy committee on contract alternates submitted by the consultant. Following the establishment of a contract, its role consists primarily of providing the consultant with necessary background information in terms of data and data sources. Its role as a decision-maker will generally be limited to evaluations as to whether the consultant is fulfilling his contract and evaluation of proposed contract changes.

A third committee should be formed as a part of the overall study guidance process. This "citizens advisory" committee is composed of representative of the local civic, cultural, and professional groups within the urban area. The

purpose of this committee is to provide for dialogue between the policy committee and the interested public. It provides assistance in establishing a goals-and-objectives system to be used for evaluation of future planning alternatives; it provides channels for liaison with the private business sector of the community; and it can aid in the evaluation of the long-range land utilization patterns that should be fostered by the transportation system. There is, however, the necessity of maintaining the committee's position in proper perspective. In several cases such a committee has seen fit to develop its own plan, choosing to publish separate and highly critical reports. In such a role its dialogue becomes a form of destructive criticism which ultimately confuses the general public and impairs the progress of the planning progress. By defining its role clearly and keeping the members informed of each phase of the Study, it is possible to adjust the proposed plans to reflect local desires or explain why modifications are not possible without a major change in public policy. Such cooperative efforts will avoid violent public opinion reactions when a plan is unveiled and will ultimately aid in public acceptance of the program.

The Staff

The administration of the Study can be established under a number of forms including those shown in Figure 1. From the standpoint of the development of a long-range plan based on a rigorous study of transportation demand, the professional

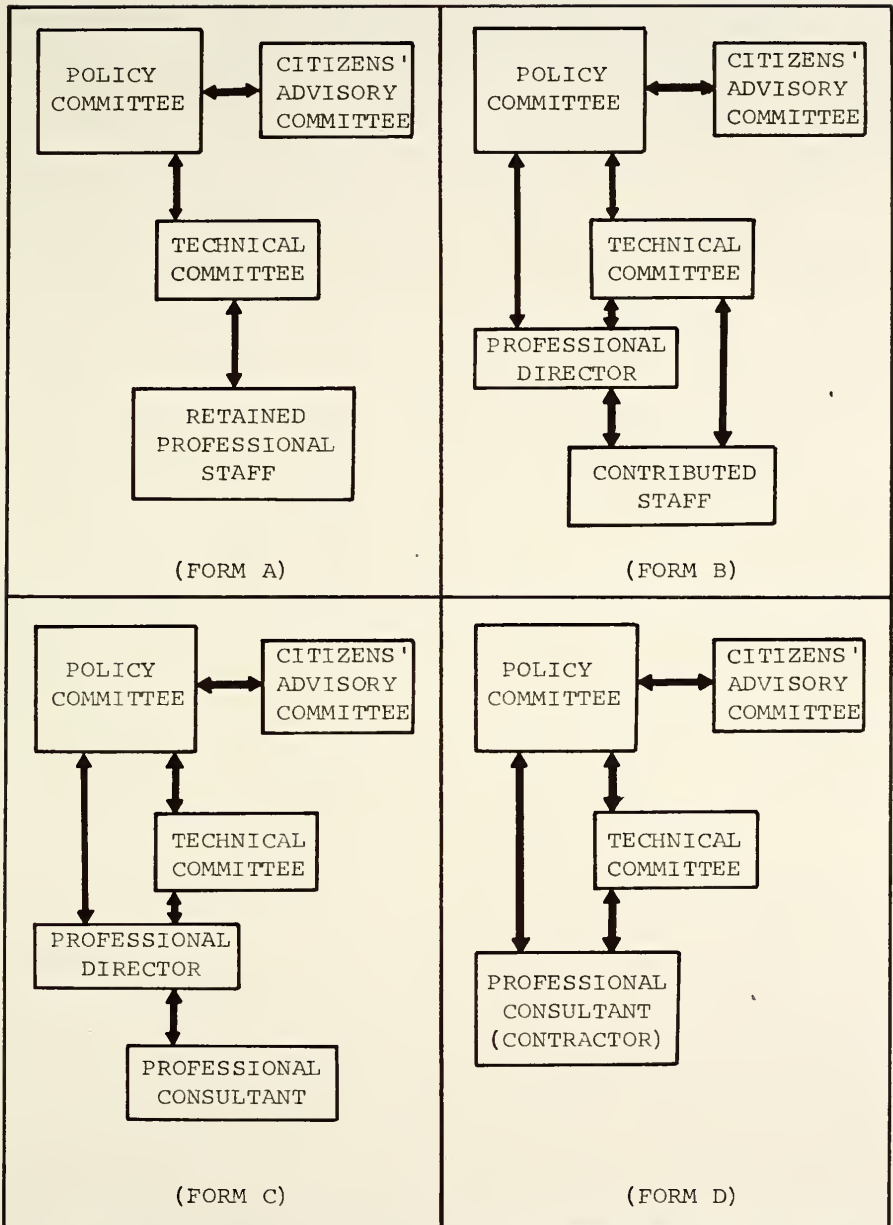


FIGURE 1: ALTERNATE STUDY STAFFING PLANS

director and staff (Form A) would seem to be an ideal solution. It provides the Study with the necessary technical know-how required to utilize complex analysis techniques. Most of the large urban area Studies are being conducted with this type of so-called "in-house" staff. However, there are few smaller urban areas that are in a position to pay the salaries required to retain a professional staff. The current shortage of transportation study personnel has prevented even the large urban area Studies from developing a full complement of professionals. Thus such a staff arrangement will seldom be feasible in a small urban area.

In some urban areas a professional director with a contributed staff (Form B) has been a successful staffing combination. The director is usually hired by the Study, although several have been appointed from within the technical committee as an economy measure. He serves as administrator of the Study operation, dividing his time between coordinating the efforts of the contributing agencies and relating the Study progress to the technical and policy committees. The contributed staff consists of local agency personnel capable of undertaking the technical programs. In the small urban areas the sources of such qualified personnel is quite limited. In some cases the SHDs, with their larger staffs and more flexible budgets, are the only agencies in a position to provide major staff contributions. Because of their involvement with all of the urban area Studies within

the State, they are better able to justify the continued need for personnel with transportation planning backgrounds. In general, the local agencies perform their services primarily as data collection units, with the exception that the city planners and the regional planning commission provide major professional services in the form of future economic, population and land use forecasts. In effect the SHD performs as a consultant to the Study as well as being a contributing agency. This staffing arrangement has a major advantage in that the personnel involved in development of the plans remain available for a continuing analysis of the travel demands and are better able to encourage implementation efforts. A disadvantage of this arrangement is the tendency for the influence of the SHD to dominate the decision process thereby increasing the possibility for the community to view the plan as biased and not representative of its overall needs. There is also a problem of questionable accuracy of data provided by local agencies that are not professionally represented on the Study staff. There have been a number of cases where the data were compiled with an attitude of providing a set of numbers with little regard for their accuracy. Such disadvantages can be overcome with a very strong involvement of each member of the technical committee. Their recognition of the uses and required accuracies of the various data can be a strong influence on the work of their own agencies, both from the

standpoint of respect for the request for data and from the justification for adequate ability of personnel assigned to obtain the data.

The use of a professional director along with the services of professional consultants (Form C) is an alternative staffing arrangement intended to maintain the local interest in the technical functions while utilizing both the technical competence and the manpower of consultants. A number of urban areas have used this arrangement because of a lack of available personnel either in the local agencies or in the SHD. It has the advantage of getting the Study initiated without the necessity of considering the time required to fill staff positions or obtain a commitment of time from a contributing agency. The disadvantage of such an arrangement can occur in the implementation and continuing phases of the Study, where the available documentations of procedures used by the consultants are the only basis for evaluating and adjusting the plan to changing growth patterns. In addition, there are economic factors to be considered in contracting with professional consultants. Their ability to obtain sufficient staff when nationwide shortage of competent personnel prevails must necessarily be reflected in the higher salaries and accompanying overhead that are part of their contracts. Thus, using their services primarily as substitute labor is difficult to justify.

The use of a professional consultant to direct and perform the Study (Form D) eliminates the problems of manpower

shortage. Many smaller cities established such contracts for transportation studies in the late 1950's and early 1960's. In a number of these Studies the plans produced by the contract were not accepted by the community as being adequate and attempts to update them to reflect new growth were hampered by lack of adequate records of the inventory data and insufficient documentation of procedures used by the consultant.

The use of consultants primarily as sources of manpower is, in general, a false economy. It is an alternative to the current shortage of personnel and has been a practical way of getting a program initiated in urban areas where petty political jealousy, encouraged by ignorance of the value of professional planning, have prevented the initiation of a cooperative program. From a long range viewpoint, however, it would seem that a maximization of the benefits of the Study experiences would be achieved by maintaining a central core of professional technicians. In most states the logical location of such a staff would be in the SHD. They could perform the phases of inventory and model development. Hopefully they could also aid the local planning agencies in projection and forecast of the economic and land use growth patterns. The services of a professional consultant could then be obtained to aid in establishing procedures, suggest modifications, and assume general guiding role, especially in the analysis and selection of a future transportation

system. Such an arrangement would provide for adequate carry-over into the continuing phase and yet would have the benefit of the broad experiences of qualified consultants.

The final decision on the staffing arrangement of a particular study must necessarily be based on the attitudes and abilities of the participating agencies. The relative youth of the art of transportation planning and the great variability in the professional backgrounds of the persons now responsible for implementing the planning process require each urban area to develop a staff in a manner that will best serve its final goal of an adequate transportation system.

CHAPTER IV. THE STUDY DESIGN

Once the Area has been fixed, the formal agreements drawn, the coordinating committees appointed, and an operations staffing plan chosen, it is necessary to formulate a well defined work program for the entire Study. Such a program should include an outline of all major activities to be accomplished, the resources of personnel and equipment required for each, and a time schedule for completion. Emphasizing this phase early in the Study provides two major benefits. First, it provides an opportunity for the staff and the technical committee members to look at how each activity fits into the program. This can be especially beneficial to the educational process of the technical committee members by describing how their own agencies will be directly involved, what their responsibilities will be and how their work contributes to the Study objectives. The second benefit of the study design results from a review of the alternative technical procedures that are continually being introduced. Selection of suitable techniques to form an adequate design requires the consideration of previous applications and performance, available skilled personnel, and the time and cost involved in their use. It is at this point that the professional aid of a consultant and the

advice of BPR can be most beneficial. Their background experiences from previous Studies and their evaluation of research results can be used in establishing the technical consequences of each of the alternatives.

The Flow Diagram

One of the most useful tools for analyzing a work program in terms of time and personnel requirements is Critical Path Method (CPM) known also in a more comprehensive form as Program Evaluation and Review Technique (PERT). CPM has had wide-spread application in the construction industry, where it is also used for monitoring progress throughout the duration of projects. Its use in transportation studies has been limited primarily to very large urban areas (George and Pyers, 1964). A number of smaller Studies have initiated their work programs with a CPM analysis but have made little use of it. Generally they have failed to update their analysis to reflect the inevitable changes and extensions of activity time durations that cannot be foreseen at the beginning of the Study.

CPM is comprised of three basic phases. The first, usually referred to as the planning phase, involves the describing of each of the separate activities within the Study and their sequence of performance. The most common representation of this phase is a graphical flow diagram such as that shown in Figure 2. The second or scheduling phase is concerned with assigning time and resource requirements to each activity. A simple arithmetic procedure is

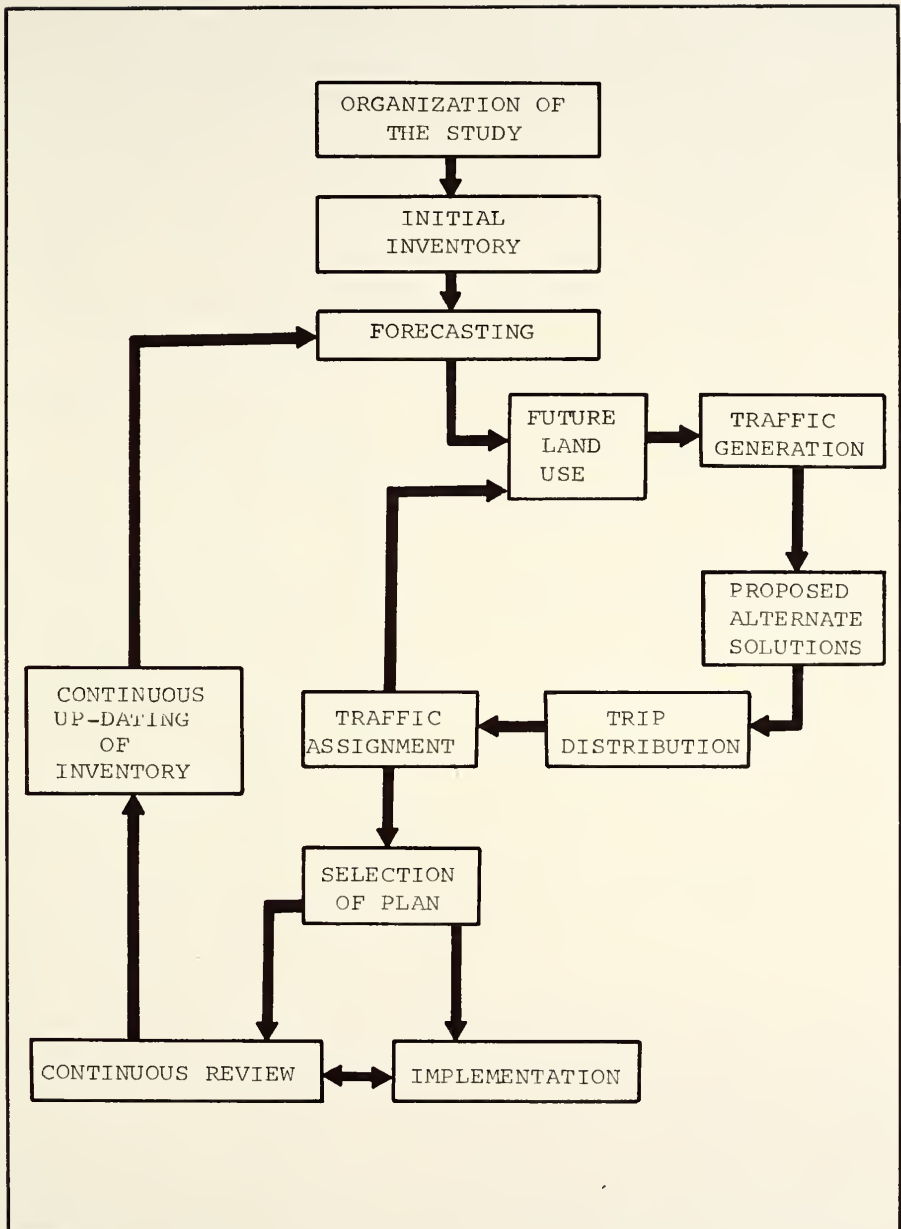


FIGURE 2: THE TRANSPORTATION STUDY PROCESS

then utilized to develop a time schedule for the activities. An analysis of this schedule points out those activities which are on the critical path. These activities must be completed without delay if the Study is to be completed on schedule. The third phase is referred to as the control phase. It consists of periodic revisions of the activity time estimates used in phase two, which in turn revises the original time schedule and possibly the activities that are on the critical path.

In order to appreciate the value of a CPM analysis, one should consider as an example a Study for an urban area of 100,000 population. In such a Study, there may be as many as six agencies completing one hundred or more major activities, each of which may consist of four to eight work items. These activities are all part of a definite sequence. If proper cooperation of the participating agencies is to be maintained, it is imperative that a well organized, realistic schedule be prepared to minimize excessive delays, and to emphasize the key role of the work of each of the agencies in the total planning process.

The complexity of a Study's CPM analysis should be based on its intended use. If the only purpose of an analysis is to provide a proper perspective of the cooperative efforts at an agency's administrative level, it is possible to use only the initial activity sequencing phase with a minimal description of the operations as shown in Figure 2. However, if it is to be used as an educational aid for the staff and

the technical committee and as a control mechanism, it should include the time and cost scheduling phase and provide for periodic updating to reflect inevitable changes.

CPM can be used initially to identify the effects of selecting particular technical procedures. An early benefit of the analysis can be realized by discovering, for example, that a particular type of mathematical model, though considered technically sound, may require inventory costs in excess of what is considered reasonable by the policy committee.

Once a set of technical procedures have been defined by the technical committee, the next step in the CPM analysis involves establishing a time schedule. This requires adjustment of personnel and equipment requirements to reflect realistic commitment demands of each of the participating agencies. It is at this time that CPM can be used effectively to justify staff positions and budget requests by describing the relation of each activity to the whole process.

The third phase of the CPM analysis consists of adjusting the estimates of time and changing dependencies to reflect the changes which occur as the Study progresses. It is an ideal mechanism to point out to one or more agencies that delays are a direct result of their lack of action, and can be extended to such activities as review and approval of the completed study phases by the policy committee or BPR.

Past resistance to the use of CPM has been generated by two major problems. Historical data on time and costs involved

in transportation planning are very limited and include the trial-and-error efforts incurred by Studies trying new techniques. The lack of a definite procedure for every phase of the Study has made the CPM analysis appear to be a glorified guessing game. The second problem noted by Studies that have tried CPM is that unlike a construction project, the Study director does not have control of the total operations staff in a cooperative planning process. The mechanism for measuring whether an agency is fulfilling its part of the legal agreement is not well established. Thus a number of Studies have experienced a rather severe deviation from their anticipated schedule because one of the contributing agencies was unconcerned or possibly unable to maintain its part of the schedule. Rather than using the schedule to illustrate the cause of the delay and to propose a revised program, most of the Studies discarded the CPM analysis and began a week-to-week program consisting primarily of explanations as to why they were falling farther and farther behind schedule.

The time and cost phase of a CPM analysis requires a detailed description of each activity including:

1. description of each work item encompassed by the activity, including alternative technical procedures that are available;
2. activities on which it depends for input data;
3. a time estimate for completion;

4. personnel and equipment requirements;
5. a cost estimate.

In order to facilitate an orderly design analysis it is helpful to establish a very broad set of process phases to which each activity can be assigned. Such a set might include:

<u>Phase</u>	<u>Description</u>
0	Organization and Administration
1	Procedure Development, Inventory and Data Coding
2	Analysis and Model Development
3	Forecasts and Projections
4	System Testing and Formulation of Alternatives
5	System Selection and Priority Programming
6	Continuing Program

Within each phase of the Study the individual activities must be defined in terms of their purpose, dependencies, and contribution to the objectives (output). Appendix A illustrates an example flow diagram for a Study in a smaller urbanized area. As an example, it necessarily idealizes the planning process. However, it does represent the general requirements and serves as a basis for the activity descriptions given in Appendix B. It should be emphasized that these descriptions have been developed only as a background example and are not intended to represent a study design for a specific urbanized area.

Resource Estimates

In order for a study design to be of maximum value to the entire planning process, it should be analyzed by the persons responsible for completing the activities. Such an analysis should include a comparison of personnel requirements with present and anticipated staffing plans. It should also include a budget estimate for each activity. Because the art of transportation planning has little in the way of documented history, the estimation of time and costs of performing individual activities is most difficult. A problem arises in determining how costs are assigned to individual activities. Some Studies have considered most of their cost to be assigned to the inventory phase, while others have assigned the majority to the analysis phase. Another problem arises when local agencies contribute staff. Often in these cases the value of the staff time can only be evaluated in terms of total dollars. Thus a detailed cost analysis is subject to the experience and imagination of the person preparing it. BPR maintains cost records on the Federal-Aid expenditures reported by the SHDs. This data can be beneficial in establishing "ball park" estimates.

The availability of technically competent personnel and the projected cost figures will undoubtedly be reflected in the adopted work program. Establishing planning efforts beyond the reasonable capabilities of the participating agencies is obviously not a reasonable approach. However, it

should be emphasized that planning is a very small part of the total cost of providing transportation, and an increased emphasis of that part may mean fewer facilities mislocated and/or improperly designed.

CHAPTER V. THE INVENTORY

There are three basic purposes for performing an inventory of existing transportation related data:

1. to establish existing deficiencies in the transportation system;
2. to provide a basis for forecasting future demand for transportation services; or
3. to define new knowledge through basic research.

Each of these purposes demands a specific level of detail in required data. Thus, the primary purpose or purposes of the Study must be established prior to defining the detail level for the various data that are to be collected.

In the smaller urbanized areas there appears to be little opportunity to attract either sufficient trained personnel or adequate financial support to carry on a meaningful research program. Thus, as a general rule it would seem advisable to restrict the Study to fulfilling the objectives of providing adequate present and future transportation systems.

From a long range viewpoint, it would seem that the primary objective of the Study should be to anticipate future demands and develop a priority program of system improvements that will adequately serve these demands. However, programs

for the identification of existing deficiencies have been virtually non-existent in most of the smaller urban areas. The initiation of a Study appears to be an ideal time to develop such programs. Thus, it would seem necessary to structure the inventory procedures to satisfy both short range and long range needs. A number of Studies have collected the same data for both planning forecasts and construction estimates for immediate improvements. Such an approach, while feasible, has met with very limited success. As an example, if each street within the urban area needs improving then it is a worthwhile effort to make detailed measurements of the roadway geometry, the traffic control devices, a detailed accident location analysis, and traffic volumes. However, these data are entirely too refined for possible use in forecasting future travel demands within the framework of current techniques. Also there are few urban areas in a position to initiate an area-wide street improvement program to immediately correct all deficiencies that may exist. Thus, the detailed inventory data must be continually updated until improvement programs can be implemented or it becomes obsolete. It would seem more practical to restrict the original inventory to the needs of the forecasting process, conducting a detailed inventory of data only in those areas which exhibit a general deficiency. Such a procedure not only can be more easily implemented, but also is more in line with the philosophy of a continuing Study process.

The Required Data

BPR, through its many research projects and involvements with earlier transportation studies has defined the following ten data types that should be identified in the transportation planning process:

1. Economic factors affecting development
2. Population
3. Land use
4. Transportation facilities including those for mass transit
5. Travel patterns
6. Terminal and transfer facilities
7. Traffic control features
8. Zoning ordinances, subdivision regulations, building codes, etc.
9. Financial resources
10. Social and community-value factors.

BPR Planning and Procedural Memorandum 50-9-67 (1967a) describes these points in detail. The collection of data related to these categories must be based on a thorough analysis of their availability, their relevance to the forecast process, the required accuracy, and the ability to store and retrieve the data once they have been obtained. Many Studies have had to expend considerable time and money in an attempt to develop forecasting models from data that were either inadequately measured or improperly coded for storage.

Procedures

The development of staff procedural manuals can be a significant aid to clarifying the need and the required form of the inventory data. The manuals serve as training guides for temporary personnel, as referral guides during the inventory process, and as a documentation of the procedures themselves. It is important to develop procedures that are simple yet adequate. The background of persons willing to take a temporary job such as that of a field interviewer necessitates simplicity. Such people are not likely to be willing to learn a complex skill that will be useful for only a short time. In general, BPR has recommended the use of established inventory procedures as described by the NCUT manuals. Several of the large transportation study groups have developed their own manuals in light of their particular objectives, data availability, and staff background. The State of Ohio contracted with Vogt-Ivers and Associates to develop a series of procedural manuals which correspond to the BPR ten point program (Vogt-Ivers and Associates, 1966). These manuals consider not only the inventory, but the analysis, forecast, and system selection as well. However, it should be noted that the blind application of procedures developed by other Studies is not a recommended practice. It is difficult, if not impossible, to determine the assumptions underlying the selection and justification of procedures by another study staff in another State.

Data Coding System

Along with adequate procedures for collection of data, a series of geographic location systems must be developed for coding the data for storage and retrieval. Two major data classes are involved: the transportation system and the land use characteristics. The urban street system provides an ideal basis for transportation system data. Most commonly this system is subdivided into functional classifications according to the primary service being provided (NCUT 1A, 1958). Four classifications are generally defined:

Freeways - limited access divided, grade separated,
high speed, through traffic;

Arterials - primarily through traffic, multi-lane with
restricted land access;

Collectors - serve as access to arterials, two to four
lanes with some land access;

Locals - serve only as land access with no through
traffic.

The technical committee, because of their knowledge of the local street system, is usually asked to aid the staff in defining the street functions. A lack of adequate background data on traffic volumes and an inconsistent use of traffic control signs and signals can make this a very difficult task. However, the major purpose of the street classification at the outset of the study is to provide a means of defining that portion of the urban street system that serves through traffic. Generally because of prohibitive cost and a lack of need for improved service on streets classified as "local,"

they are not used in the inventory. The resulting "selected system" is then coded by establishing a numbering system for the intersections, thus defining each section of the system as a "link" connection two "nodes" (BPR, 1964a). Figure 3 illustrates a street coding system.

A number of Studies have found that their street selection and coding process was hampered by a lack of adequate base maps of the Area. The additional time and expense required to prepare current maps generally will be more than justified by the reduction in data coding errors. The use of a photogrammetric mapping consultant to prepared a new base map has been an ideal solution for such updating. It does not require that the study or any of the local agencies retain sufficient technical staff to prepared the map, and provides an added bonus of current aerial photos that can be a significant aid in establishing the land use coding system. Because the development of base maps can be considered a part of comprehensive urban planning, it is often possible to accomplish this task with the aid of the "701" program administered by HUD.

The land use characteristics require a code that is based on the identification system used to define each land parcel. As a part of the continuing process, which could include the establishment of a "data bank" of urban characteristics, the individual parcels can be identified by either lot and block number, street address, or a geographic

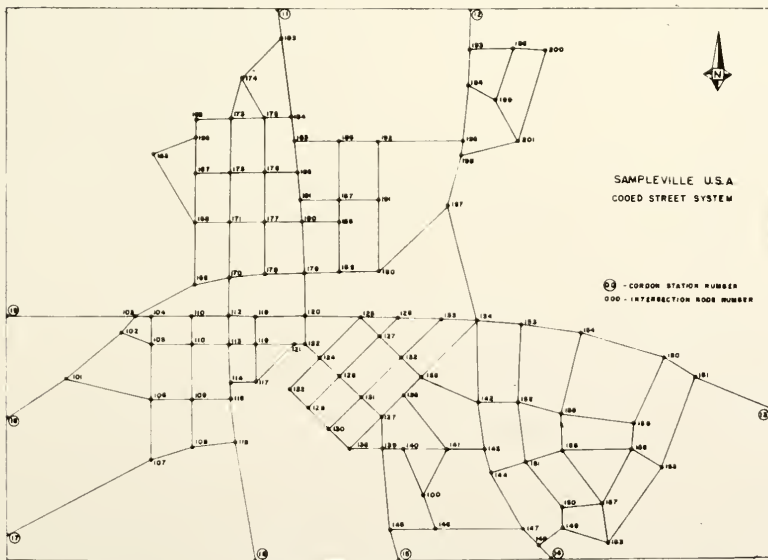
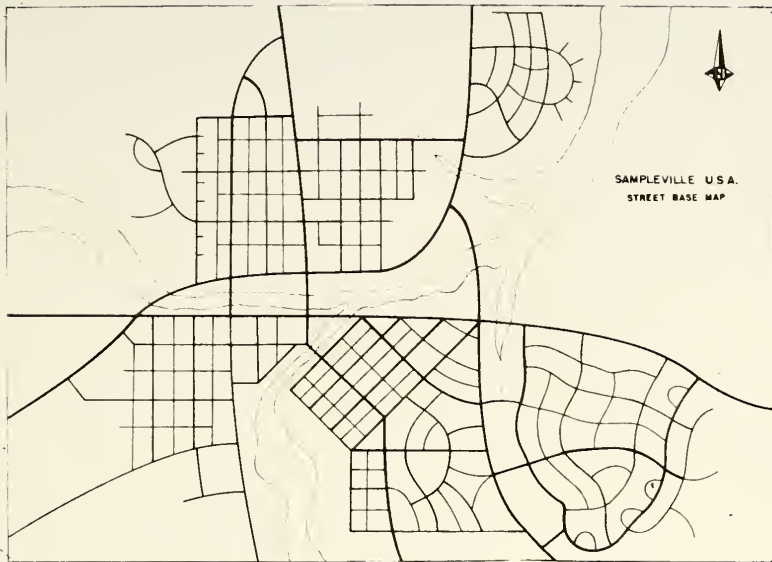


Figure 3 Sample Street Coding System

grid coordinate system. From the standpoint of simplicity and minimization of confusion to inventory personnel, the street address is considered to be an ideal coding unit. The flexibility of electronic data processing (EDP) and the current interest being shown by the U. S. Department of the Census tend to emphasize the relative simplicity of coding to the smallest unit and combining (aggregating) the data to any number of analysis units such as block face, census tract, school district, political ward, or postal zone. Maxman (1968) in his work on the development of an urban data system (data bank) for a smaller urban area points out many advantages to the development of a parcel coding system. He describes many of the coding systems available and the many uses of the data that are being collected by local agencies in formats that make them of little use to other agencies. By developing a common format that the transportation study, the school board, the parks department, and others can use, the cost of obtaining the data and maintaining a current file can be shared, often resulting in a lower total cost to each agency.

If the Study must provide the entire cost of the inventory of land use characteristics, usually a group measure of the characteristics is considered adequate. In such a case the coding unit is established as an "inventory zone" which consists of a block or possibly several blocks. All data which are to be measured, such as types of land use,

numbers of dwelling units, and population are summarized at this level. The establishment of these zones (see example in Figure 4) should be based on a consideration of the uses of the data. Whenever data are grouped together the individual characteristics of each data set, such as the land use and intensity of use of a parcel, loses its individual identity. Since the variations in land use have been shown to be very much related to variations in travel demand, the combining of parcel data should not hide or tend to average out these variations. In the central part of the urban area a single block is often defined as a zone. Farther out from four to eight blocks might be combined where single family residents form a lower intensity of land use. In the suburban areas ten to twenty blocks might be combined, depending on the current and anticipated intensity of use. The criteria for establishing these zones are not well established. The availability of existing data such as the U. S. Census or land use classifications and the cost of obtaining new data by inventory procedures heavily influences the decision process.

Enumeration of the Data

Once the data coding systems have been established, it is necessary to select the method of measuring the required data. A determination must be made as to whether a complete inventory is necessary or if it may be possible to obtain a satisfactory estimate by utilizing some type of statistical

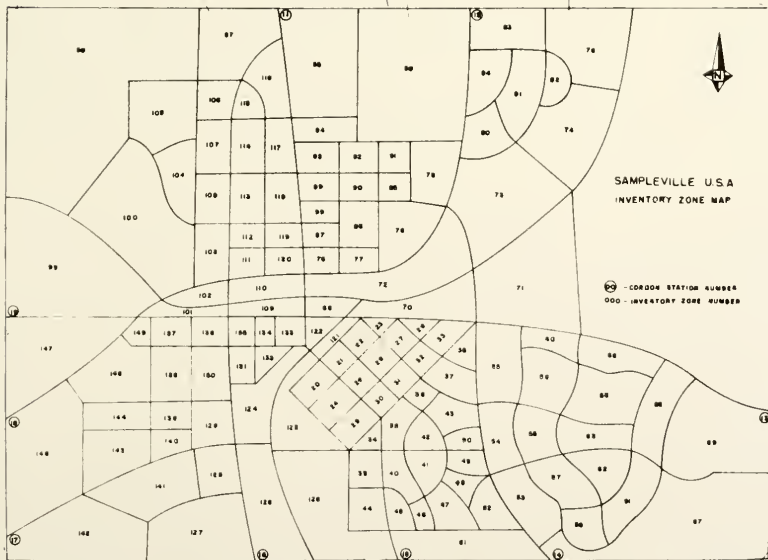
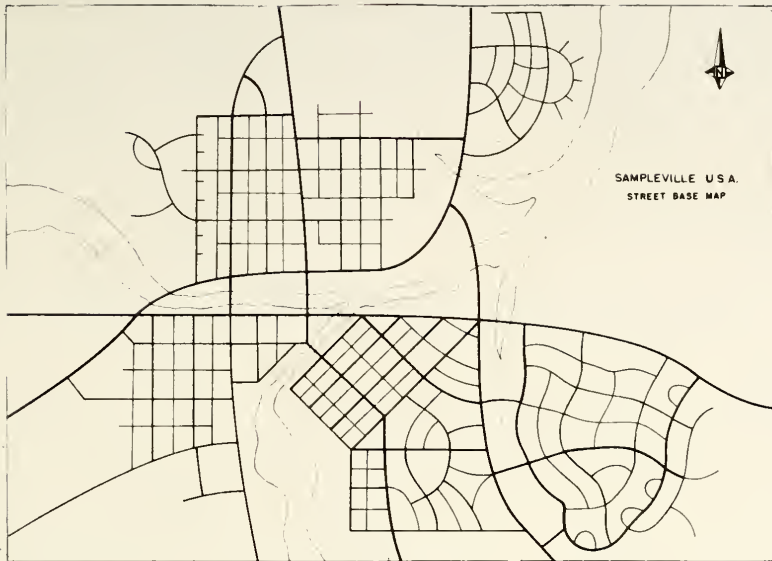


Figure 4 Sample Inventory Zones

sampling procedures. Total enumeration of the data can be a costly and time consuming process. The decision as to whether a particular type of data can be estimated is based on two factors:

1. the variation (different values) that the data might have, and
2. the accuracy required to obtain an adequate estimate.

As an example, the estimation of a street's ability to carry traffic requires a measure of the physical dimensions such as width and number of lanes. If all of the streets have been built to a single standard, then a measurement at one location would be sufficient to estimate the measurements of the entire system. If, however, there has been little standardization, then many measurements will be required. Figure 5 lists the inventory data suggested by BPR and typical types of enumeration required for a smaller urban area.

Those data requiring total enumeration create problems primarily concerned with developing economical inventory techniques simple enough to be used by temporary study staff. As an example, consider the collection of land use data. Previous Studies and continuing research have shown that the type of use (industrial, commercial, residential, etc.) and the intensity of that use (number of employees, square feet of floor area, dwelling units per acre, etc.)

INVENTORY DATA	ENUMERATION	COMMENTS
Population	Total	Several Studies used sampling with limited success
Income	Sample	Available from the home interview
Employment	Total	Usually restricted to State employment records
Motor Vehicles	Total	Usually from State motor vehicle registrations
Land Use	Total	Level of Detail governed by multiple uses of data
Physical St. System	Total	Sufficient data to define the capacity of system
Accident Experience	Total	Usually requires coding police accident records
St. Traffic Volumes	Sample	Sampled by type of street & time of day
St. Travel Speeds	Sample	Sampled by type of street & time of day
Parking Supply	Total	Often only the central business district
Parking Demand	Sample	Interview to determine intended destinations
Daily Trip Patterns	Sample	Home, commercial vehicle, & cordon interviews
Goods Movement	Sample	Interview commercial vehicle owners
Financial History	Total	Financial statements and legislative history
Community Values	Sample	History is often difficult to piece together

FIGURE 5: ENUMERATION OF THE INTERVIEW DATA

have an influence on the trip potential (Mitchel & Rapkin, 1954). Because of the many different types of businesses which generally exist in an urban area, and because the field inventory staff should not be classifying, but only counting and measuring them, it is advantageous to use a large number of land use categories (See "Standard Land Use Coding Manual," HUD, 1965). The number of categories will vary, but few studies have used in excess of one hundred different types. A problem arises in justifying such detailed information for a forecasting technique that will generally use at most ten different land use types. The justification comes from the reduction in the mistakes in misclassification by the inventory personnel.

A second problem which exists in the total enumeration process concerns the most economical source of data. Employment data could be obtained by interviewing each employer within the urban area. Such a procedure would be quite adequate but is excessively expensive in light of employee records generally available from state employment offices. However, data from such sources is often not properly coded for estimating employees per inventory zone. Thus, it requires additional indexing and/or hand sorting. Recent work by Shunk (1968) indicates that employment data may be extremely valuable in updating travel demand forecasts. He describes a procedure that eliminates the need for a number of other types of data. If such a procedure is utilized, it may prove

to be economical to obtain adequate employment data by direct interviews at each place of work.

Some of the data required to establish the urban travel patterns can be obtained by sampling rather than total enumeration. This is appropriate where past research work has shown that an adequate estimate of trip patterns can be obtained by expanding sample data measurements to reflect those of the entire urbanized area population. In utilizing sampling it is necessary to satisfy statistical requirements as to the random selection of samples. This generally requires that some characteristics of the entire population be known. In the case of daily trips, three separate sample groups are generally defined:

1. Person trips by auto or public transit;
2. Vehicle trips by trucks and taxis; and
3. Vehicle trips by all modes which enter or leave the area.

The home (dwelling unit) has usually provided the basis for sampling the internal person trip movements (NCUT 2B, 1958). It is a definable data source from which samples can be taken. The most successful technique is a personal interview of the persons in the sample dwelling unit. Included in the data to be obtained are:

1. The number of trips made in a single 24-hour period;
2. The purpose of each trip;
3. The origin and destination addresses;
4. The mode of travel (auto, transit, walk);

5. The time of day the trips were initiated; and
6. Dwelling unit characteristics which influence trip-making, such as personal income, number of autos owned, and size of the family.

The data from each dwelling unit are considered to be representative sample and are expanded to estimate the trips which would be made by all persons in the area. For example, if a ten percent sample is taken, each sample trip represents ten estimated trips with the same characteristics of origin, destination, and purpose. Selection of the dwelling units to be used as samples requires that the total number and location of the dwelling units be known.

A dwelling unit interview does not adequately sample trips made by commercial vehicles (trucks and taxis). Thus, it is necessary to sample these on a separate basis. Three alternative sources of samples to be interviewed are vehicle registration records, commercial truck listing services, and public carrier tax records. An adequate identification of all vehicles operating in the area generally requires additional cross checks to eliminate duplication. Research work into adequate identification of commercial vehicles has not been conclusive to date. The primary source of trouble is the lack of current records on the location of operation of these vehicles. However, once the sample has been defined, it is then necessary to contact the vehicle driver and obtain a trip record for a twenty-four hour period. Such a task is difficult in that interviews take away productive

time from the driver. Close coordination with the vehicles owners, possibly through the citizens advisory committee is essential to obtaining adequate sample data.

A determination of the vehicle trips entering and leaving the Area must be obtained by interviewing a sample of the vehicles as they cross the Study boundaries. This necessitates using a roadside interview technique. Since the driver is being interrupted in the process of a trip he is most aware of his origin, destination, and purpose. However, he is least likely to appreciate the interruption. Thus, the interview must be very short, obtaining only the necessary information. Selection of the samples requires a knowledge of the total number of vehicles which cross the Study boundary at each entrance (cordon station). Such data are most commonly obtained as a part of the street traffic volume counting program or may be available from the state-wide counting programs conducted by the SHD.

Aggregating the Trip Data

In general, it is not economically feasible to design a street system for each trip origin or destination, and even the analysis of the separate movements is an overwhelming problem. Usually these trip end points are grouped together into common trip producing (generation) units commonly referred to as traffic zones. Such zones include one or more inventory zones and are represented as a single node on the coded street system (See Figure 6). Definition of traffic

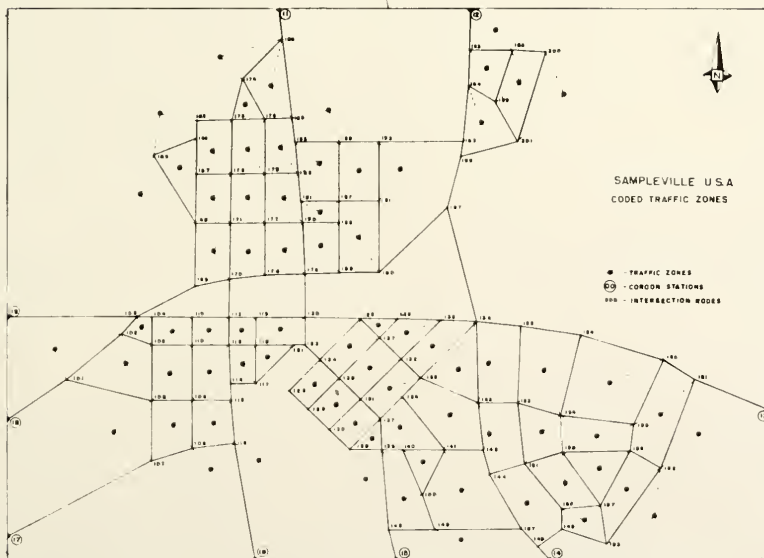
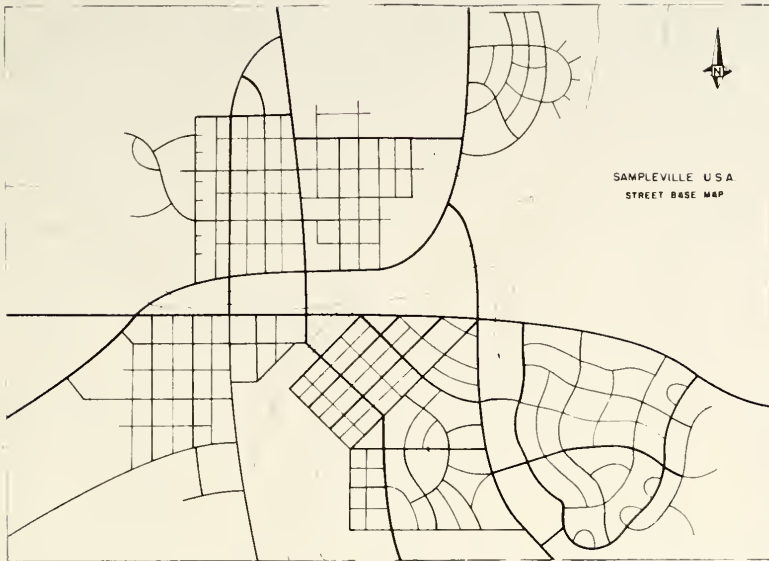


Figure 6 Sample Traffic Zone Coding

zone size and configuration is dependent on the type and intensity of land use. A number of criteria have been used by various Studies. In order to obtain a realistic representation of travel on the streets adjacent to the zone, its size should be restricted such that it produces no more than 10,000 trips per day. A number of Studies found that it was impossible to analyze future travel demands because of excessive numbers of trips being generated by a single zone. Another factor to be considered is the types of land use. Some Studies have maintained homogeneous uses within each zone. That is, residential and commercial land uses were not placed in the same zone. Still another factor often considered is the use of major arterial streets as zone boundaries, under the assumption that common interest land use activities cannot function across the traffic barrier created by an arterial. Once these zones are established, the expanded trip data obtained from the interviews are assigned to each zone according to their origins and destinations. These results are tabulated in a "trip table" such as the example shown in Table 1.

Sample Size and Accuracy Checks

Whenever a sampling procedure is used to estimate a particular set of data, it is necessary to determine an adequate sample size and several tests to see whether the resulting estimates are adequate. Determining the sample size of trip pattern interviews has been the subject of much research.

TABLE 1: SAMPLE DAILY PERSON-TRIP TABLE

TRIPS FROM ZONE (i) TO ZONE (j)											
TRIPS FROM ZONE (j) TO ZONE (i)	j \ i	1	2	3	4	5	6	7	8	9	10
	1	***	25	100	12	840	600	329	12	521	11
	2	30	***	12	921	49	320	74	181	394	421
	3	97	18	***	398	210	489	899	40	616	731
	4	15	890	420	***	28	381	219	143	335	285
	5	812	71	219	35	***	221	482	210	486	102
	6	600	308	520	402	240	***	301	76	260	151
	7	340	79	941	221	469	313	***	164	530	230
	8	20	194	29	157	214	89	183	***	352	173
	9	498	390	640	321	491	272	502	341	***	53
	10	21	402	700	291	94	137	245	181	49	***

Currently BPR recommends sample sizes based on an analysis of the total population of the Area (Sossiau and Brokke, 1960). However, several research studies are attempting to develop adequate techniques that will allow the use of smaller sample sizes. Selection of a particular size for a particular Study should be made only after a thorough analysis of the data sources. The economy of a smaller sample must be compared with a possible increase in the cost of developing acceptable forecast models with data that statistically is more variable.

The validity of the expanded sample data is generally tested by a series of "accuracy checks." One alternative check consists of comparing the total Area population estimate from the sample with independent estimates such as the U. S. Census figures. A second one compares work trip destinations to employment data. A third and possibly the most critical test is the so-called "screenline check." It is made by comparing the expanded sample trips which cross a natural transportation barrier such as a river with the actual crossings obtained by volume counts on the streets which cross this barrier.

The Data Set

Once the data locations have been identified, the enumeration or sampling performed, the validity tests performed, and the data coded, it is available for the analysis phase. It should be emphasized that data classes described by BPR

and shown in Figure 5 are not intended to be restrictive. They have been developed from a very short history of transportation planning. Hopefully, future research will be able to better document the importance of inventory data. However, until a better understanding of the travel demand phenomena is available, it will be necessary to continue to develop models of present data as a means of forecasting future demand.

CHAPTER VI. ANALYSIS AND MODEL DEVELOPMENT

The measurements taken in the inventory phase of the Study are of very limited value unless they can be related to the underlying desire for transportation and its interaction with land use patterns within the urban area. Intuitively, travel is an expression of a need to communicate coupled with a knowledge that this need can be satisfied at a particular location. However, planning for the future transportation needs of an urban area requires more than intuition. It requires an understanding of travel motivation. Such an understanding requires a critical analysis of the activity patterns of the urban area including:

1. An economic base analysis of the area;
2. A population growth study;
3. A land use pattern study, relating economic opportunity to physical limitations of geography and topography;
4. An analysis of the transportation demands exhibited; and
5. A study of the political control and financial limitations which influence the entire activity pattern.

Improved techniques for relating urban travel demand to urban activity patterns are being developed through continuing research programs. As a better understanding of the underlying

motivations for travel evolves, it gives rise to new analysis techniques. These are continually being tested for accuracy and practicality. Selection of particular analysis techniques to be used for evaluation of an urban area requires an understanding of their contribution to the Study objectives. Such an understanding can only be developed by relating the past experiences in transportation planning to the objectives and technical limitations of the Study.

The Economic Base

An economic base analysis provides a perspective of the role of the individual Area in the economy of the region and the nation. It is a complex evaluation of the economic forces which tend to control the productivity of an area. Because of its complexity, it is often accomplished by a professional economic consultant. If a community is interested in expanding its economic base by attracting new industry, it must be able to identify and sell its potential. Since the economic future of the community is a part of comprehensive planning it is possible to combine the transportation study effort with aid available from the HUD "701" grants. The cost to the local agencies will usually not be greater than if they had developed their own limited economic estimates. At the same time the Study has a firm basis for making future forecasts of economic activity.

If the community cannot justify the need for a detailed analysis of its economic potential, it is possible to develop

economic trend measures that may be adequate for transportation planning. A number of recognized techniques have been developed. A manual by BPR (1965a) describes these as they related to transportation planning. Several Studies have used one or several of the techniques to develop their own economic base. However, these techniques were developed as tools to aid persons qualified to make economic analyses. Thus, several of them, such as the economic base multiplier and the input-out method require the services of experienced economists for accurate interpretation. Figure 7 indicates the general procedure. Some of the simpler methods such as growth trend lines, component growth, and national economy ratios are simple enough to be applied with little professional aid. These techniques are primarily based on the projection of past trends rather than on the identification of causes for these trends. An urban area which exhibits a relatively stable economy may be able to use such an approach with a great deal of success. However, a mechanical projection without technical competence should not be encouraged. The economic base study is the framework for the economic forecast which in turn forms the basis for population growth, land requirements, the accompanying travel demand, and future revenues for plan implementation.

Population

The population of a particular Area is closely related to the economy that will support it. Thus, a study of

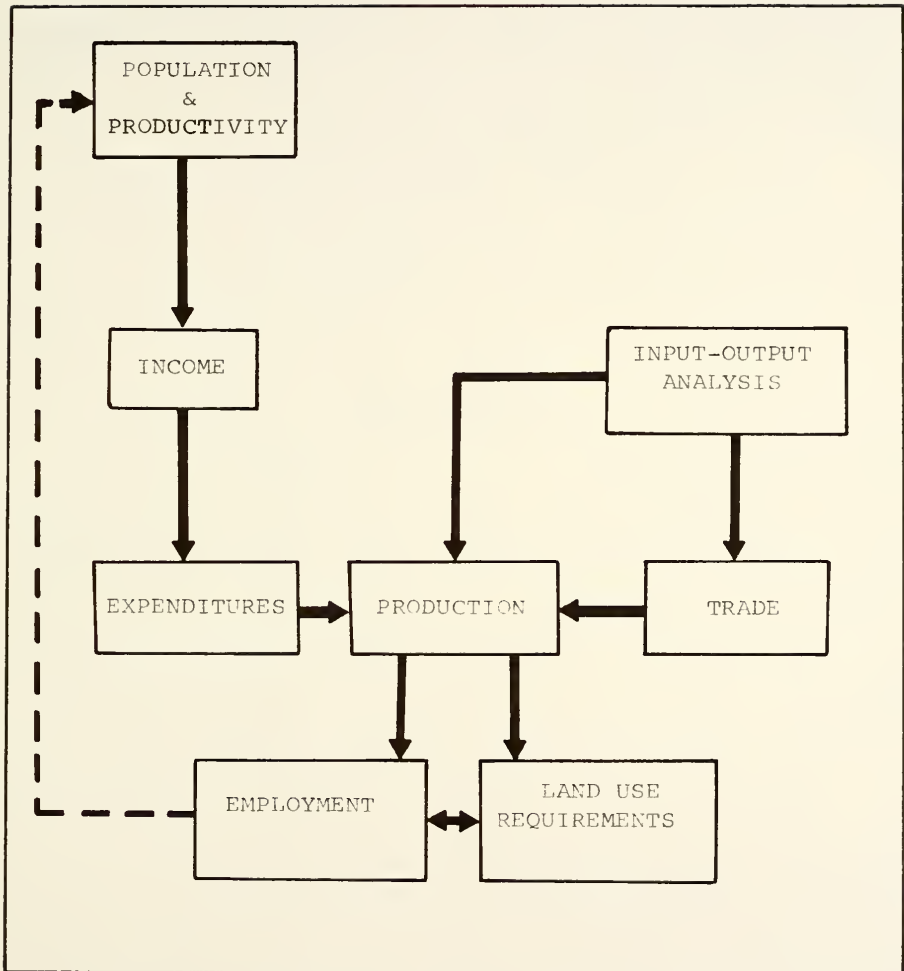


FIGURE 7: ECONOMIC ANALYSIS FLOW DIAGRAM

population trends necessarily must include an economic evaluation. If a consultant is retained to do the economic analysis, generally a population study will be provided as a by-product of that analysis. However, if the study staff does its own economic analysis, it will usually also do the population study. There are a number of empirical techniques which have been developed to aid in population analyses (BPR, 1964b). As in the case of the economic base study, the development of population estimates without technically competent personnel is not encouraged.

Land Use Patterns

The land use patterns within a study area at a particular point in time are the result of the economic activity supporting the population within the physical limitations of the topography. The demand for transportation is strongly influenced by this pattern. The identification of the relationships between the land use pattern and the transportation system is one of the major research topics currently being studied. A pattern analysis serves two purposes:

1. the establishment of possible causes of the pattern formation, essential in forecasting future patterns, and
2. the establishment of relationship between travel demand and the land use pattern, essential to the forecasting of future travel demand.

There are a number of techniques which are currently being used to establish the trends in urban land use activity patterns. Among them are:

1. numerical ratios of the percent of the various types of land use (see Table 2);
2. graphical trends exhibited in maps and charts prepared for various time periods;
3. mathematical models involving the interaction of time, space utilization, and compatibility of adjacent land uses.

The first two techniques are the most commonly used by urban planners. They provide trend measures that the planner uses to develop an "intuitive feeling" for the growth patterns. This approach is considered to be a traditional planning method, requiring that the planner have a great deal of experience and a personal knowledge of the Area. It is well established and understood by many planners, thus it is readily applied to most Studies. The disadvantage of this approach is that it can only project trends, thus it is difficult to apply in the testing of alternative future patterns. In smaller urban areas where growth is relatively stable this disadvantage may be only an academic point.

The use of mathematical models for land use forecasting is not a widely accepted practice. There are several reasons for this. The science of model development to predict human actions is still in its infancy. Thus the models that have

TABLE 2: SAMPLE LAND USE GROWTH RATIOS

LAND USE TYPE	AREA (sq. miles)		PERCENT	
	PRESENT	FORECAST	PRESENT	FORECAST
Residential	21	39	39.6	47.0
Commercial	3	5	5.7	6.0
Manufacturing	5	8	9.4	9.7
Public Buildings	2	4	3.8	4.8
Parks & Open Space	12	16	22.6	19.3
Transportation	10	11	18.9	13.2
Vacant	53	83	100.0	100.0
Unusable	40	10		
	2	2		
TOTAL	95	95		

been developed are for the most part either unrealistic or too complex to be applied to an operational study. In addition, the data required to calibrate them is either unavailable or too expensive to acquire. It is primarily for these reasons that the traditional trend analysis technique remains so popular. The advantages of model applications lie in their ability to evaluate many patterns, some of which may bear no resemblance to present day forms. This approach, which is called "normative planning" (Stewart, 1968), is discussed more in detail in Chapter VIII. Continued research hopefully will overcome the deficiencies described above and allow the use of land use models for evaluating growth forms in light of overall community objectives. However, in a smaller urban area with a stable economy the absence of a model analysis of land use patterns generally will not critically effect the study objectives. A traditional trend projection based on an adequate study of the economic potential of the Area often will serve adequately.

Transportation Demand

The analysis of the demand for transportation that is exhibited by the inventory trip table involves a study of the interaction of the land use pattern and the transportation systems. Most commonly this interaction is described by a set of mathematical models. These models relate the land use characteristics in each zone such as dwelling units, commercial floor area, or available automobiles to the

number of trips generated; they relate the distance between the zones, the travel speed possible on the existing street system, and the capacity of the links of the system to the distribution of the generated trips; and in larger urban areas they consider the alternate forms of transportation such as auto, bus, or commuter train. There are generally four classes of models used in transportation planning. These are: generation, modal split, distribution, and assignment.

Generation

Trip generation can be defined as the number of trips (persons, vehicles, or goods) generated (produced or attracted) by a traffic zone. The inventory trip table provides estimates of the current values. A trip generation manual prepared by BPR describes in some detail the types of analyses suggested for developing the generation models (BPR, 1967b). One of the major problems in developing generation models is the lack of a unique equation or technique that will adequately predict trip potential. Early Studies used average generation values such as the number of work trips per dwelling unit. Averages, however, are not sensitive to variations in the characteristics of the traffic zones. Several Studies have developed a stratified average method (see Table 3) to account for different levels of economic ability, auto availability, and other factors that seem to influence the total trip generation (Walker, 1968). This approach has been well

TABLE 3: AVERAGE PERSON-TRIPS PER HOUSEHOLD
(Walker, 1968)

HOUSEHOLD CHARACTERISTICS	ENVIRONMENTAL CHARACTERISTICS		
	LOW	MEDIUM	HIGH
LOW-LOW	***	2.88	3.19
HIGH-LOW	5.51	6.03	5.29
LOW-MEDIUM	7.57	6.94	6.26
HIGH-MEDIUM	7.96	7.53	6.84
LOW-HIGH	8.47	8.38	7.79
HIGH-HIGH	9.08	9.54	***

*** Data not available

received by transportation study personnel with limited backgrounds in mathematics. The philosophy of the approach is that the development of a stratified trip rate table helps to give the technician a "feel" for the trip variations within the Area. This concept is very similar to the traditional approach to land use forecasting. The disadvantages lie in the development of the rate table. Because the table is based on stratified averages, it is limited to the historical trends in generation. Also, there are few tests available to check the statistical validity of the rate values. Consequently, if alternative land use forecasts are to be tested, the rate table technique may not adequately reflect the changes in generation influences by a change in the land use pattern.

The most commonly used technique for developing generation models is mathematical regression. It is a well defined technique that can be used to develop a model with little prior knowledge of its form. Examples of overly simplified trip production models might be:

$$\begin{aligned} \text{Home-based Work Trips} &= A \text{ (Dwelling Units)} \\ &+ B \text{ (Population)}; \end{aligned}$$

or

$$\begin{aligned} \text{Home-based Work Trips} &= C \text{ (Population)} \\ &+ D \text{ (Car Ownership)}; \end{aligned}$$

where A, B, C, and D are mathematically determined relationships (parameters) between dwelling units, population, car

ownership, and the resulting trips produced. There are two steps involved in any mathematical model development. In the first step (evolution) the form of the model is being sought. It requires a systematic testing of the statistical validity of models to determine what urban characteristics really influence trip making. It is a highly technical process, requiring personnel with a strong background in mathematical statistics. A number of studies have attempted to perform this phase of the generation analysis without the aid of a qualified statistician. The availability of computer programs makes it possible to perform the mechanical manipulation of statistics with little or no difficulty. However, the interpretation of the program output is another matter. It is relatively simple to develop a model that will duplicate the inventory data, but often difficult to develop one which will provide valid predictions. Thus models in many cases have proved to be statistically unsound, intuitively invalid, or contained variables that cannot be forecast with any degree of certainty.

The second step in modeling is referred to as calibration. This step assumes that the form of the model has been determined. The technique is limited to estimating the magnitude of the constants such as the A and B in the equation above. It can be accomplished by a person with very limited statistics background. However, selection of the correct model is the critical problem, requiring adequate

professional counsel. It involves an analysis of the local study characteristics such as size, population density, geographic region, topography, and general stability of the economy. If a model form has been evolved in a study with similar characteristics, it may be possible to calibrate that model (Jefferies, 1968). Because the trip generation has not been well defined, the process of selecting model form and significant variables should not be taken lightly.

The final decision to evolve a model, to calibrate a model, or to use a trip rate table should be based on the total resources, both manpower and money, of the Study. Evolution requires the services of a professional statistician and a large set of inventory data; calibration requires a previously evolved model form but a much smaller set of inventory data; and the trip rate table requires a large set of inventory but little statistical background.

Modal Split

The mode used to accomplish a trip is a very important part of the study in a large urban area. The effect of mass transit on the travel pattern is discussed in a manual prepared by BPR (1967c). A transportation system composed entirely of highways and streets is not economically or physically possible. Thus an analysis of the travel demand must include the decision process involved in selecting the mode of travel. Most commonly this has been accomplished in much the same manner as the trip generation analysis.

Modal split models have been developed which estimate the percent of the generated trips that will use a mass transit system. By forecasting this percentage it is possible to determine a balance between the mass transit and highway systems.

In the smaller urban areas, however, the use of public transit is very minimal, usually less than five percent of the daily trips (Wynn & Levinson, 1967). The only realistic form of public transit is a bus system operating on public streets. It serves primarily as the only available mode for those people physically or economically unable to use an automobile. These people, primarily school children and the elderly, do not require enough buses to significantly effect the highway system. This has led most smaller urban area Studies to totally ignore public transit. However, the inventory data contains valuable information on the needs of transit. These data should be given to those agencies responsible for planning the future of transit as a community service.

Distribution

The origin-destination pattern exhibited by the inventory trip table is modeled by considering the various relationships involved in distribution of the generated trips. Distribution models attempt to balance the trip productions with the trip attractions of each zone. Conceptually this distribution process is related to the number of possible

destinations (attractions) and the distance to these attractions from the production zone. The validity of a model is measured by how well it accomplishes the production to attraction process. Most commonly screenlines similar to the ones used to check the inventory data are used to make these comparisons.

A great deal of research has been aimed at evolving distribution models. Because the distribution process has been easier to identify than generation, there are a number of evolved models available. Presently there are three general types that are operational. That is, it is possible to develop the necessary input data required to calibrate them. The first of these models is the Fratar model, developed for a transportation study in Cleveland (Fratar, 1954). Conceptually it suggests that a future zonal trip interchange forecast is a function of an existing trip pattern expanded according to the expected growth of each zone. It assumes a completely closed system, that is, no zones are created or dissolved. Its entire prediction is based on the ability to predict a general growth factor for each zone. It has been used extensively and proven to be quite adequate when restricted to the framework of its assumptions. The forecast of cordon station to cordon station trips has been quite satisfactory in that the growth of the station potential must be based entirely on the expected increase in volume on the rural highway. Using this method to forecast the trip

distribution within the Area has not proven to be satisfactory in large or rapidly growing urban areas, primarily because the model assumptions are violated. Growth of the urban area generally implies that new zones are added to the system. These additions alter the land use pattern, often reflected in changing uses within the original zones. Also, because the model assumptions assume a stable growth, it is very difficult to determine the effects of alternate land use patterns. The Fratar Model has been used by some Studies because it is a relatively simple and quite economical method of obtaining a trip forecast without an extensive study of generation characteristics other than a zone growth factor.

Presently the most commonly used distribution model is the Gravity model, first introduced into transportation studies by Voorhees (1955). Conceptually it assumes that the trips from one zone are distributed to all other zones in direct proportion to the available attractions (i.e., work trips to employment opportunities) and in inverse proportion to the difficulty of getting to the zones (i.e., some measure of travel time or cost). The Gravity model theory assumes that by separating trips by purpose it is possible to identify a set of travel restriction values (F factors) in the calibration process. In large urban areas there may be as many as ten purposes, whereas in smaller areas three may be adequate (see Figure 8). For the forecasting process, it is assumed that the calibrated F factors do not change

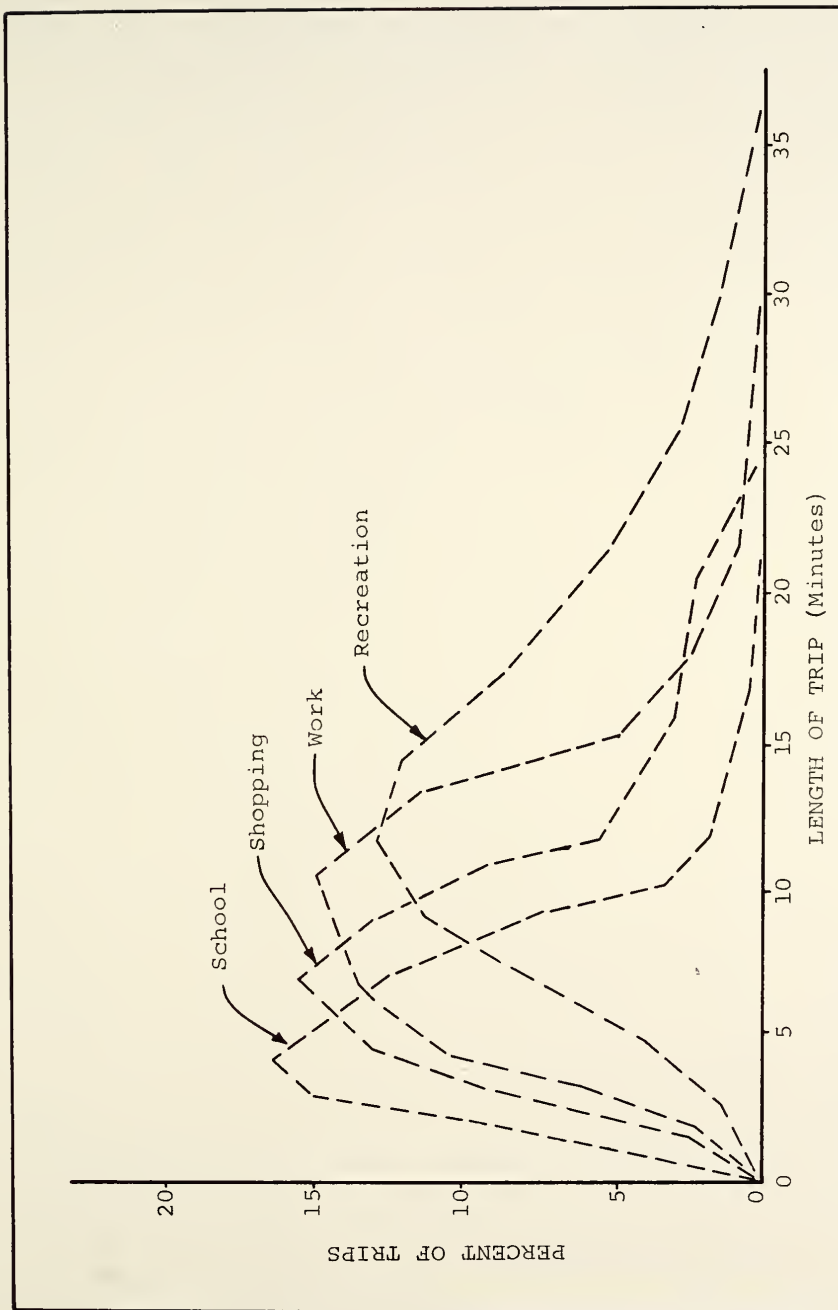


FIGURE 8: SAMPLE TRIP-LENGTH FREQUENCY CURVES

over time. One advantage of the model is its ability to be calibrated with a relatively small inventory sample, thus possibly reducing the cost of the inventory phase (Ben et al., 1964). Other advantages which have caused it to be so commonly used involve its simplicity of concept, its documentation, and the availability of computer programs to perform the mechanical calculations (BPR, 1965). In actual application there have been several problems which can be classed as disadvantages. The calibration process is a trial-and-error technique as it is now performed. It requires not only the inventory trip table, but also an estimate of zone-to-zone travel time as measured by the existing street system. There is also some doubt about the assumption of travel characteristics remaining constant over an extended period of time. Research to date has not been able to either verify or reject these assumptions (Heanue & Pyers, 1965). The data required to make adequate tests over time and over various types of urban areas has not been available. Currently the model is accepted by many urban transportation planners on the basis that it is reasonable and has not been shown to be inadequate.

A distribution model that has been the subject of widespread discussion in the research field is the so-called "Opportunity Model," first related to traffic in the Chicago Study (Chicago Area Transportation Study, 1960). This model is based on a hypothesis that the probability that a

particular trip will terminate in a particular zone is a function of the probability that it could not have been served (satisfied the purpose) in a zone closer to the origin. It has as its foundation a limiting case of a mathematical probability distribution. A number of authors have pointed out its superior mathematical basis, noting also that its calibration process does not require the assumptions or the degree of refinement of zone-to-zone travel time estimates required by the Gravity model. The Opportunity model has not been widely used for several reasons. On one hand it is difficult to develop a simple statement of its concept without referring to mathematics. This in itself has caused a type of negative reaction to its use. On the other hand, the use of probability distributions requires an adequate population to satisfy the assumptions of random occurrence and normality of the distribution. As in the case of the Gravity model, the Opportunity model has been documented and computer programs written to perform the computations. However, the complexity of its description and the uncertainty involved in the calibration have led many transportation planners to choose the more easily understood models. Current calibration studies being conducted by such groups as the Chicago Transportation Study and the New York State Department of Transportation will undoubtedly aid in overcoming this negative reaction (Ruiter, 1967). Hopefully they will also be able to identify the minimum size of the

Study for which the assumptions can be considered adequate. Presently, however, the use of the Opportunity model in a smaller urban area is neither required nor is it entirely valid in light of the small population on which the calibration must be based.

A number of trip distribution models have been developed in addition to the ones described in the preceding paragraphs. A few are only modifications of one of those described. Others such as the application of mathematical linear programming are based on entirely different concepts. However, their use in a practical application to an operational transportation study has been virtually nonexistent due to unavailability of required inventory data and/or the inability to perform the mechanical calculations on available EDP equipment. Future research will undoubtedly create additional conceptual models, some of which may be successfully integrated into the operational Study. Presently, however, it would seem that adequate distribution projections in smaller urban areas should be accomplished either by the Fratar generation-distribution process or by the Gravity model coupled with adequate generation models. Selection between these two should be based on a professional assessment of the characteristics of the Area in terms of size and growth, availability of study personnel and/or consultant aid, and time and money allotted.

Assignment

Once an estimate of origin-destination trip distribution has been determined it is necessary to convert these general desired movements to the equivalent vehicle trips operating on the street system. This is the assignment phase of the process. The general philosophy of assignment is that it is necessary to develop a logic model that will select a route in the same manner as the vehicle driver would do so. The process first requires that the available system be defined. Such information as the location and connections of the existing streets are available from the inventory in the form of the coded street system. Additional data relating average travel speed on each link to various traffic volume conditions and the capacities of these links is also available from the physical inventory. These data are then used as a basis for modeling the route selection.

Presently there are two types of assignment models that are at least partially operational. The first is the proportional type model first used to determine the percentage of traffic that would be diverted to a new highway facility such as a freeway. The concept of the model is to predict the proportion of the trips from some origin zone to some destination zone that will use each available route. The evolution of the model requires a technique for establishing the alternate route paths as well as one to determine the effects of average travel speed, cost of operation, and

congestion on the route selection process. This model has been successfully applied where the number of available routes did not exceed two or three. However, in most urbanized areas it is impossible to restrict trip movements to such an extent. Because the definitions of criteria required to make realistic proportioning of the trips have not been clearly established, a second model referred to as the All-or-nothing Minimum Path Assignment model has been widely used (BPR, 1964a). This model is based on an assumption that all of the trips between the two zones use a single route. Selection of that route is based on the minimum time or distance path between the two zones. The argument for such a model is that it represents the true desired route. Such information can be quite useful for estimating major corridors of trip movements within the urban areas. However, in considering the real system it should be noted that the speed of travel on a street is negatively affected by the traffic volume. Thus, the minimum time path is changed as the trips are added to the street system. In order to compensate for this effect, several solutions to the minimum path are obtained by adjusting each of the link travel speeds according to their "volume-capacity ratio." That is, after each of the zones' trips have been assigned to their minimum time paths, the volume assigned to each link is compared to the capacity of that link and the initial travel speed adjusted to reflect this condition. After three to five solutions (iterations) have been obtained the average volume

assigned to each link is computed as an estimate of the true value. This technique is, of course, completely artificial, but tends to give a reasonable representation if the system does not offer too many essentially equal paths between zones. If too many parallel paths are available the solutions tend to be no better than the initial iteration. This condition occurs most easily when too many streets are defined as being arterials and collectors. Urban areas with basic grid pattern street systems with a lack of well defined major streets are most susceptible. There are several techniques for overcoming this problem, thus the best approach for a particular urban area should be discussed with the consultant prior to the definition of the selected system. This particular point is quite important because the actual assignment computations, usually accomplished by EDP, will not indicate that the parallel path condition exists. Thus, the program output can easily be accepted as being an adequate estimate, when in fact it may be quite inadequate.

Assignment is possibly the most over-emphasized part of the estimation process. One reason for this is the desire for numbers on which to base street system designs. This over-emphasis has been exhibited in several cases where designers have used the assignment program output to design individual intersections. The concept of the all-or-nothing assignment does not satisfy the demand for such values. Design values can only be determined by a detailed analysis

of the assignment values determined for a group of adjacent streets within a movement corridor.

There have been a number of research studies on the development of more realistic assignment models. There are several that have a strong conceptual basis but are as yet not practical. When considering the smaller urban areas these refinements may be of limited value. By a reasonable restriction of the street system used in the assignment process, the present all-or-nothing model can produce estimates that are adequate for the planning process. This is particularly true when it is noted that the assumptions of the generation and distribution process are reflected in the accuracy of the trip table estimates.

Political Control and Financial Limitations

In order to make realistic plans for future transportation systems it is necessary to determine how the community will react to a plan. This requires an analysis of the political control of the community, the civic action of its residents, and its financial ability and response to past obligations.

The political control of the community affects transportation planning in several ways. It dictates the attitudes toward land development controls (zoning). It dictates the attitude toward providing adequate community services (education, recreation, etc.). This in turn may be

reflected in the community's attitude toward Federal Aid (aid versus interference).

The civic action of the community is an indication of its support for schools, parks, and other forms of urban environment improvements. If a program is to succeed, it must be compatible with community values. These values are seldom exposed, but instead escape definition by even the most knowledgeable resident. Thus, an analysis of past activities is necessary to aid in establishing scales for these values.

The financial ability of the community is most difficult to determine. The historical records of taxes, tax rates, bond issues, and improvement programs can provide much of the needed information. Also, since the State and Federal Governments are involved, there must be some analysis of their roles in financing transportation. Future urban development continues to be increasingly important to Congress. Thus, the financial support picture must be based not only on historical ability, but also on problematical future Federal involvement.

CHAPTER VII. COMMUNITY DEVELOPMENT CRITERIA

Throughout the relatively short history of transportation planning there has been a rather strong criticism of the sophistication used for such analyses as described in Chapter VI. It has been suggested that the implementation decisions made by the responsible elected and appointed officials only remotely reflect the efforts of planning studies (Mathewson, 1966). If this is true, then there would appear to be little justification for such efforts. However, recent comments and statements by concerned groups seems to indicate that the political decision process has been unable rather than unwilling to assess the value of planning proposals. The majority of planning alternative evaluations has been limited to factors that can be given economic value such as construction and operating cost, with almost total disregard for the social effects.

Recognition of the Problem

In December of 1965, the American Association of State Highway Officials sponsored the Second National Conference on Highways and Urban Development. One of the most emphasized points of this conference was the problem of coordinating the planning process with decision making. Of the ten

"Williamsburg Resolves" agreed upon by the participants, three directly concern community values. The text of these three are as follows:

"Planning agencies should emphasize the identification and evaluation of urban values and goals as an integral part of comprehensive transportation planning. There should be encouragement of research to develop more systematic techniques for rating all values and costs to be weighed in evaluating urban plans.

"The planning and development of facilities to move people and goods in urban areas must be directed toward raising urban standards and enhancing the aggregate of community values, both quantifiable and subjective; it should be recognized that transportation values (safety, comfort, beauty, convenience, and economy in transportation) are a part of, and are to be given proper weight in the total set of community values.

"Urban planning agencies should work actively to achieve (a) public understanding of the planning efforts, and (b) participation of decision making agencies at appropriate points in the planning process.

"Throughout the planning process, information on progress should be widely disseminated. To the extent feasible, data from planning studies should be made available to government agencies, and to civic, business, and other organizations when the information can be useful in furthering community development.

"Means of getting views of decision makers during the course of plan development should be devised as an essential element in bringing about ultimate implementation."

These statements would seem to indicate that the problem has at least been recognized. Implementation of an adequate method for establishing decision criteria based on community values is the next step.

Current Approaches

A number of large urban areas have initiated programs aimed at identifying community values and establishing weighted decision criteria that will allow the planner to evaluate alternative improvement proposals. Schimpeler (1967) indicates that community values can be expressed as a set of goals which are in turn defined by more specific statements of planning objectives. He points out that the selection of a group of people capable of establishing a community's goals and the procedure for assigning criteria weights to clearly defined goals are two of the major problems. Involvement of those who influence the urban development decisions would seem to be essential. This involvement might be obtained by one or a combination of the following:

1. elected officials;
2. panels of informed and interested citizens;
3. identification and interviewing the so-called "power elite" of the community;
4. a random sample interview of the urban population;
and
5. a voter referendum.

The limited tenure of political office tends to encourage the overemphasis of short range improvements. Thus, the establishment of long range goals that are truly representative of community values must not be left entirely to the elected officials. Only by direct citizen participation can the planning process effectively define the adequacy of

proposed improvements. Schimpeler utilized the informed panel as his source of community values. Whether this is the best source is still the subject of debate. At any rate, he suggests that they were able to function adequately and were able to structure the following general goal categories including specific objectives:

1. Public Safety Program Development
 - a. Insure safe public facilities.
 - b. Provide for adequate public safety regulations and their enforcement.
 - c. Provide for the removal of contaminants (solid, liquid and gaseous).
2. Public Utility and Transportation Development
 - a. Minimize maintenance costs of public facilities.
 - b. Insure maximum effectiveness of public utilities, by design and locational considerations.
 - c. Develop a balanced, effective and integrated transportation system which provides for the accessibility requirements of each land use.
3. Economic Development Programs
 - a. Develop public improvement programs within available financial resources.
 - b. Maintain highest equitable property values.
 - c. Insure effective utilization of mineral, vegetation, air and water resources.

- d. Establish a strong economic base through commerce that will bring money into the community.
 - e. Establish trade development that provides maximum convenience to consumers.
 - f. Insure the optimal utilization of all land.
 - g. Achieve increased disposable income for all people.
4. Cultural Development
- a. Preserve historic sites and areas of natural beauty.
 - b. Promote adequate public libraries, museums and cultural activities.
 - c. Protect meaningful local tradition and encourage civic pride.
5. Health Program Development
- Establish the mechanism for adequate preventive and remedial health programs and facilities.
6. Education Program Development
- Develop educational facilities and opportunities for citizens at every level.
7. Welfare Program Development
- a. Eliminate injustice based on discrimination.
 - b. Develop needed public welfare programs.
 - c. Encourage development of religious opportunities.
 - d. Develop an aesthetically pleasing environment.
8. Recreation Program Development
- a. Establish open space programs.

- b. Provide adequate recreational facilities utilizing parks, rivers and lakes.

9. Political Framework

- a. Improve the framework (channels, systematic use) for citizen participation in governmental functions.
- b. Establish equitable taxation policies (bases, mixes, rates).
- c. Achieve efficient governmental administration, representative of all citizens.
- d. Develop adequate government staffs and personnel programs (high job standards, reasonable salary ranges, effective delegation of authority).
- e. Establish sound governmental fiscal programs.
- f. Develop an effective, long-range, metropolitan-wide, planning process.
- g. Establish effective control mechanisms.

10. Housing Development

- a. Encourage rehabilitation and conservation neighborhood programs.
- b. Provide adequate low cost housing.
- c. Develop neighborhood units.
- d. Promote a wide variety of housing types as required within the community.

Using these goals as a basis, the panel then established a scale of weights for each of the development criteria. These

weights were used to assign numerical measures of utility to the goals and objectives. Finally, the utility measures were used to evaluate the effectiveness of transportation design concept alternatives.

The above described procedure is presented as an example of the current thinking in the area of effective decision making in the urban planning process. There is presently no single accepted approach to the problem. However, the important point is that the decision process must be an integral part of planning; and hopefully adequate techniques can be developed to make this a more readily understandable task.

The Smaller Urban Area

In the smaller urban areas the integration of the decision process into the planning phases has been limited largely to discussions of the problem. Total contract planning by consultants and a lack of resources to implement any plan have both contributed to this situation. However, there are three phases of a successful planning process that depend heavily upon policy decisions. The first is a general policy toward the future growth of the community. Adequate estimates of future economic growth must be based on a policy toward industrial and commercial development. Decentralizing industrial firms are interested in locating in areas where there is evidence of a positive effort toward providing for an adequate urban environment. Thus, a prediction of

industrial growth must include a commitment to encourage this growth. The second phase concerns the community attitude toward land use development. Orderly growth requires adequate control in the form of zoning and access restrictions. These in turn require a policy commitment on the type and extent of control that will be fostered. The third phase concerns the use of minimal standards to evaluate the adequacy of existing or proposed transportation facilities. The establishment of standards should be based on a balance between ideal community goals and the availability of resources. In most urban areas transportation facilities standards already exist. Historically, they are related only to satisfying vehicle movement. Their origin may be the SHD, the county, or the municipality. One of the major problems in establishing a common set of standards is the wide variation between the minimum levels acceptable to each of these agencies. The revenue poor municipalities generally accept a much lower minimum than the SHD. The T.O.P.I.C.S. program described in Chapter II is an attempt to overcome this problem by providing additional funds for street improvements.

The standards applied to the street systems are usually defined in terms of levels of service for traffic volume, travel speed, and safety. Figure 9 is an example of travel time standards. The establishment of these curves requires a policy decision on what constitutes a minimum acceptable level of service. Ayad (1967) in his work on traffic assignment techniques presents a strong argument for the community

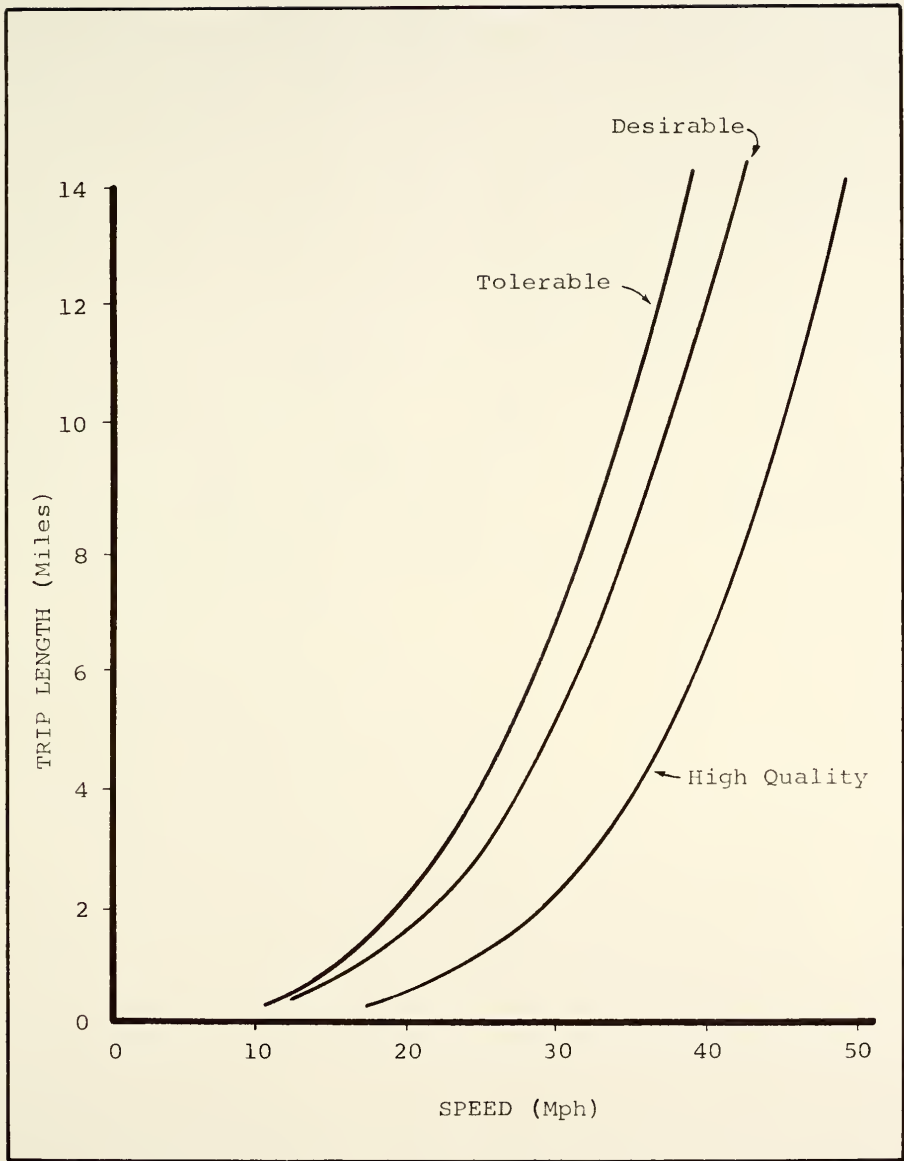


FIGURE 9: COMMUNITY TRAVEL TIME STANDARDS (Vogt-Ivers, 1966)

making its own decisions on level of service. This in turn requires a commitment of resources to maintain the service above that level. Each standard should be defined by establishing its effect on the community value system.

The future of transportation planning as an effective tool for improving urban environments will depend largely on its relationship to the community decision process. If an adequate liaison is established between technical forecasting and community improvement efforts then the expansion of the transportation system can be a major force in the process. However, if these two remain on separate courses, as they have in the past, there undoubtedly will be an extension of the ineffective role of planning efforts.

CHAPTER VIII. FORECASTING

In the preceding chapters the discussion has been concerned with the procedures necessary for the development of models of urban growth and travel demands. The magnitude of the efforts required to complete these procedures tends to infer that they are by far the most important part of the planning process. However, such an inference ignores the fact that the lead time necessary for planning and design of transportation system improvements requires a forecast of travel demand. Thus, the models are only as good as the estimates of future urban activity. These forecasts are quite simple in concept. The problem is to determine the magnitude of economic and social activities of the urban area for some future horizon year, and from these data estimate the corresponding travel demand. However, the development of realistic estimates is not quite so simple. Generally it is necessary to make a series of forecasts five, ten, and twenty years in the future. These allow the rate of growth to be expressed in terms such as the economic growth as a function of the gross national product versus the birth-death and migration estimates of the population. Since the probable accuracy of a forecast generally decreases with an increase in the time lapse between the forecast and the event, it is

necessary to make estimates on a periodic basis. Unless sufficient emphasis is placed on the importance of these estimates, there is a tendency to treat them as mental exercises to be accomplished by any available personnel regardless of qualifications.

The Forecast

The sequence followed in forecasting for future travel demand consists of:

1. Area economic activity related to the gross national product and regional attractions;
2. Employment requirements of the economic activity;
3. Population increases created by the economic growth;
4. Land use requirements to support the economic growth;
5. Distribution of growth to the various geographic sectors of the Area;
6. Estimation of the resulting commercial activity patterns;
7. Estimating of the resulting population and dwelling unit characteristics; and
8. Estimation of the resulting travel demands.

Economic Growth of the Area

In the large urban area, Study forecasts of economic activity, population, and land requirements generally have been accomplished by an economic consultant. Economic forecasting requires an analysis of the local resources and

an appraisal of how they can compete in the general growth of the county, the region, and the state. It is a natural extension of the economic base study described in Chapter VI. Few study staffs have been able to retain personnel qualified to perform this task. Because private business is in constant need of analyses of economic potential a number of qualified consulting firms are available. In several cases, the services of research groups within universities have been utilized.

The forecasting process for the smaller urban area differs from that of the large urban area only in the scale of economic growth potential and possibly the feasible growth patterns. The actual economic forecasts have the same basis and generally would be most effectively developed by a professional consultant. Several Studies have attempted to perform their own forecasts, but unless a very capable economist is available, it does not seem advisable.

Distribution of the Growth

Once an economic forecast with accompanying population and land requirements has been made, it is necessary to assign this growth to particular geographic sectors of the Area. A sector generally consists of five to twenty traffic zones and corresponds to the "planning areas" often used by land use planners. This step requires the efforts of local planners who are familiar with the current and past trends in growth, zoning, and land speculation. This part of the

forecast can have a great effect on transportation planning. The interaction of community values and transportation system efficiency can suggest many alternate patterns of distribution of the activity growth.

The concept of prescriptive (normative) as opposed to descriptive land use planning has been proposed as a method of evaluating alternative patterns of growth. Descriptive planning is concerned with describing the growth pattern that is most likely to occur. It is based on past growth trends, making the assumption that future growth will most likely occur in a similar pattern. Normative planning suggests that the planner is in a position to encourage or discourage certain development by comprehensive legal or economic land use regulations. It has as its basis the philosophy that future growth should be encourage in patterns that will reflect favorably on the goals and objectives of the community. The strong relationship between land utilization and available transportation is well established. Thus, by prescribing land use growth patterns that are in keeping with community values, it is possible to estimate the needs of a transportation system that will foster such patterns. However, the normative approach is highly dependent on the development of evaluation models. Thus far, success in land use models has been quite limited and most planners are not able to make effective use of them.

Once the estimates of urban growth (land requirements and population) have been assigned to particular sectors, it

is necessary to develop corresponding estimates of employment, commercial trade factors (retail sales) and dwelling unit characteristics (income, car ownership, family size). This requires a series of rate analyses and cross checking with the overall population and economic growth as well as a study of the trends in cultural changes. These analyses may indicate that several patterns of assigned community growth are feasible. If at all possible, each of these patterns should be considered as forecast estimates, thus creating alternative demands.

The Travel Demand

Presently the prediction models described in Chapter VI are based on the characteristics of the traffic zone. These zones have been defined on the basis of reflecting the travel on a realistic arterial street system. For the present it appears to be more accurate to subdivide the sector growth into traffic zones than to develop traffic models that cannot distinguish a street system with links spaced closer than two to three miles. Planners have indicated a reluctance to make such allocations. They suggest that there is little basis for assigning a twenty year growth forecast to the detailed level of a traffic zone. In the absence of working land use models the procedures used to make the zone allocations are largely intuitive, relying heavily on the experience of the local planners. Because forecasting is necessarily a continuing process such a seeming shortcoming can

be at least partially overcome in the periodic reappraisals.

The forecast of travel demand between zones (future trip tables) consists of applying the forecast zone characteristics to the calibrated travel models. The procedure is almost totally a mechanical process if the assumptions under which the models were calibrated remain valid. Thus future trip tables can be prepared to reflect the travel demand for each of the alternative land utilization patterns. Research is continuing in an effort to test these assumptions.

Along with estimates of person travel, the forecast phase of the study should also estimate goods movement. This part of the forecasting process has been virtually ignored by most Studies. Little in the way of accepted procedures are available. Current research efforts hopefully will correct this problem. In the smaller urban areas, the problem of goods movement generally can be handled by a study of terminal demands and the estimation of commercial vehicle trips.

Financial Forecast

The programming of improvements to the urban street system is highly dependent upon the availability of financial support. The history of transportation financing and the changing role of the Federal Government make the prediction of future sources and amounts of financial support a highly subjective process. However, the early identification of major differences between improvement costs and revenue forecasts

can provide a basis for either justification of additional taxation or a reduction in the acceptable minimum standards.

There is no generally accepted procedure for making revenue forecasts. In fact, some Studies essentially have neglected this step because of their inability to define feasible procedures. But in most Studies, the general approach has been to evaluate the historical revenue-expenditure pattern and, by utilizing the zonal characteristics developed in the growth forecast, prepared a schedule of anticipated revenue. By involving the entire Study committee structure in the financial forecast, it may be possible to develop a much stronger tie between minimum acceptable standards and financial ability. Too often standards are not related to the ability to support them, thus the resulting plan becomes completely unrealistic.

CHAPTER IX. FUTURE SYSTEM ALTERNATIVES

Thus far the discussion has been centered around the estimation of travel demand within the urban area. Adequate estimates of this demand are extremely important. However, the formulation of improvement plans can be achieved only through a program of testing and evaluating alternative solutions. This requires competence to evaluate the consequences of alternative decisions and to express these consequences in a form that is understandable to the Study policy committee. Ferguson (1966) suggests that the development of a single workable solution to an engineering problem is no longer an adequate approach. Plans must represent an efficient allocation of community resources and a step toward the achievement of a better urban environment.

Criteria Establishment

In order to assess the consequences of an alternative decision, a set of criteria must be established. The entire process of alternative evaluation, which consists of conception, testing, compromise, and retesting, is dependent upon the connection between the planning process and the decision process as described in Chapter VII. Leiper (1966) identifies four general criteria as being particularly important:

- (1) Efficiency of investment and conservation of resources must be a prime consideration. Barring a revolutionary reallocation of resources, older cities will continue to be financially overburdened.
- (2) Quality transportation is essential. Rising incomes generate demands for improved transportation. Investment should be put into facilities that have maximum utility in changing times.
- (3) Flexibility is the key to a sound transportation development strategy. While transportation system decisions inherently tend to commit major expenditures in facilities that will be fixed over a long period of years, it should be possible to program the improvement so that a change in policy may be reflected by an adjustment to the new conditions. Too often commitments to build are held as constraints because of the expense of plan preparation, with little regard for the resulting consequences.
- (4) Feasibility must be uppermost in setting development priorities. While broad planning and promotion can stimulate public acceptance of new ideas, effective transportation programming must concentrate on policies and projects which can be initiated in the relatively near future.

Deen (1966) suggests that the choices are often influenced by what percent of the cost must fall to the local jurisdictions. Hamburg (1966) points out that most of the system already exists and cannot be ignored or removed because it represents a very substantial investment that performs at least a limited service. Thus, the alternate system selection phase of the Study would appear to call for a very close coordination between technically feasible solutions and the constraints of the economic and political decision process.

Effective System Evaluations

Few Studies in the small urban areas have been able to develop meaningful system evaluations. An over-extension of expenditures for the inventory and/or analysis phases of the Study and a shortage of qualified transportation planners have both contributed to this problem. The initial emphasis to fulfill the requirements of the 1962 Federal Aid Highway Act created too many Studies that have not been able to get beyond the analysis or the forecast phases. It is at this point that the services of a transportation consultant can be most valuable. In the early phases, the consultant is able to advise the Study as to which techniques will most likely provide adequate estimates of future travel demand. Generally he is no more capable of performing these somewhat routine operations than the Study staff. However, in the system evaluation phase he is in a position to provide a direct contribution that is generally not available from the Study staff.

The qualified consultant has developed the ability to properly interpret the traffic flow and congestion exhibited by model forecasts. Most commonly, evaluation procedure consists of assigning the future trip tables to the existing street system, and making selected improvements to relieve the apparent congestion (American Municipal Association, 1964). Because of the artificial actions of the traffic model, it is possible to introduce system additions and

modifications that will provide enough apparent capacity, but which are totally unrealistic. Such is the case if freeways are added where less extensive improvements would be adequate. Because of the relatively high speed and accompanying large capacities of freeways, it is possible to eliminate much of the apparent congestion by the addition of a single freeway. However, by analyzing the trip pattern, it will generally be noted that the majority of the trips are excessively long, moving at high speed, on a circuitous route. This defeats one of the principles of good urban transportation design, that of minimizing vehicle miles of travel which in turn minimizes accident exposure and total required miles of street. Many other false interpretations of model forecasts are also possible without the aid of experienced transportation planners. Since the consultants are better able to compete for the limited number of qualified personnel presently available, it would seem logical to utilize their services. An added advantage to this approach occurs in the citizens' evaluation of the technical adequacy of proposed plans. Public reaction has forced several studies to retain a consultant to review the technical feasibility of plans already subject to evaluation by their own staff. The community tends to view local agency technical evaluations as too biased, especially those of the SHD. Thus, the consultant is cast in the role of a capable disinterested party. In this role he would be in a better position to make

evaluations if retained at the start of the system analysis phase.

The use of a consultant for the system evaluation phase of the Study does not exclude the Study staff. The consultant, while being technically qualified, generally is not in a position to establish a set of evaluation criteria that adequately reflect the local decision process. Thus, the staff have the continued responsibility of converting technical solutions into understandable decision alternatives. This involves the conversion of the goals and objectives described in Chapter VII into standards that can be used to measure the effectiveness of proposed additions and modifications to the transportation system.

Presenting the Alternatives

Finally, analyses by the staff and the consultant must be combined into alternative plans. These plans might include:

1. Do nothing but general maintenance;
2. Widen present arterials, remove all on-street parking, and provide off-street parking; or
3. Provide a series of entirely new facilities to encourage growth on the perimeter of the Area.

Each of these alternatives must then be evaluated in light of the land use plans that were used in the initial forecast of the travel demand. Finally, the committee structure with the active participation of the staff and the consultant must

select the plan which has exhibited the most positive influence on the structured community values. Under the present status of community value scales, this selection process depends heavily upon the intuitive insight of the persons involved. Hopefully this process can be advanced to the stage of the traffic model, thus reducing the number of subjective evaluations now required.

CHAPTER X. PLAN DEVELOPMENT

Once the general plan has been selected, it becomes necessary to establish the quantitative measurements required to implement this plan.

Street System Improvements

The street system improvements for most smaller urban areas will consist primarily of modifications and additions to the arterial and collector street system. In general, the justification for freeways will be as a part of the Interstate System. Thus, the quantity estimates will include street widening, the removal of on-street parking, the addition of medians, the acquisition of right-of-way for new facilities, and in a few cases, the vacation of streets no longer useful to the transportation system. The programming of these improvements is necessarily a function of the demand and available financing. However, in order to maintain a good public attitude toward planning, it is advantageous to schedule the improvement of obvious deficiencies within a short time of the original inventory. This provides the public with physical evidence of the planning efforts, and encourages them to more actively participate in the implementation of the entire program. If no improvements are exhibited within a reasonable length of time, the people are likely

to consider the entire plan just another waste of public funds.

One of the major problems in urban areas is that the land developer traditionally has initiated developments prior to any transportation plan. He has assumed that the ensuing demand in the form of overcrowded existing streets will justify the needed facilities. This assumption generally has been correct, but has often created a land use development that continues to emphasize an unbalanced travel demand. Thus, to insure an orderly growth it is necessary to control land developments. Such control could be political, in the form of zoning, but more realistically it should be a positive action, consisting of a dialogue between the planners and the developers. They should be encouraged to develop according to an overall plan by identifying the long range advantages that they can achieve.

Transit System Improvements

The transit system improvements will necessarily be limited by the community attitude toward providing a mass transit service. In the large urban areas, transit is being pushed as a possible solution to the peak hour congestion that occurs before and after the traditional work day. In the smaller areas, the densities of employment are generally low enough that a peak hour problem is either nonexistent or lasts for possibly fifteen minutes. Thus, transit would appear to be somewhat useless in this regard. However, if

the community is interested in developing a more compact land use pattern, using the so-called cluster development concept, it may be that a transit system will be superior form of movement. Present trends indicate that community values in the smaller urban areas do not reflect any major change in attitudes toward land development practices. However, the future actions to solve the problems of the large cities may create a new philosophy.

Terminal Improvements

The development of parking requirements hinges heavily on the attitude toward parking facilities as a part of the transportation system. Traditionally, transportation planning has ignored parking except for the additional right-of-way obtained for on-street spaces. In the future this additional right-of-way will be difficult to justify in light of spiraling land costs. Thus, the transportation system financing program must accept the responsibility for providing adequate terminals or force the revenue poor local governments to bear the entire cost. Unless one of these two approaches is followed, the street system improvements will not function adequately for lack of sufficient terminal space. This point is especially critical in the case of the existing "downtown" and its future role in the urban area. The present lack of adequate off-street parking has been a major contribution to the decline in local business. If the community wishes to retain the downtown area as a functional part of the urban

area, then it must attempt to encourage rather than discourage its use.

Land Use Controls

Once a plan has been selected every effort should be made to encourage the land use pattern defined. One method is to exercise the police power of the local municipalities and develop rigid zoning ordinances; another is to require protective covenants on all property that is annexed to the municipality. Neither of these approaches has a very strong history of success. The political process has had a habit of being very inconsistent in enforcing zoning. This is due in part to the fact that a realistic plan was not available, and thus the developer who requested the zoning change had only to indicate the increase in property tax and other revenues to convince the municipal officials that his own plan was a good one. With adequate planning efforts, such proposals can be evaluated for their total effect. For example, if an industrial firm is allowed to build on the site of its choosing, without regard to its effects on local utility demands and potential pollution to air and water, it is not possible to effectively define its value to the community.

Thus, an effective land use plan should function to encourage development that will benefit both the developer and the community. This is why the economic forecast is so important prior to the land use proposals. An unrealistic plan has very little chance of succeeding because it depends

entirely on a negative police power. Historically such an approach has generally failed.

Programming the Plan

The final step of each cycle of a planning process is the preparation of an implementation schedule. This consists of a program of improvements over a period of years, an estimate of the cost and a suggested means of financing it. It should take into account the present deficiencies that could not be corrected as a maintenance item. Some of these improvements may have to be temporary (stop-gap). The urgency of each must be established in relation to tolerable design standards. The remaining improvements should be scheduled in relation to the growth rate of the demand and the anticipated sources of revenue as reflected by total community service needs.

Because this is a continuing study process, sufficient flexibility should be provided by the improvement program to allow for changes and adjustments dictated by the periodic updates. However, while this flexibility should be emphasized, there is danger of the planners becoming too casual about the program, assuming that the update will correct any mistakes.

Publication

The final step in any type of analyses is the preparation of a formal report of the findings, and transportation planning is no exception. However, too often such a report

is accepted as a final solution to a continuing problem. In many cases the reports tend to create such an illusion. One of the major faults of persons involved in any technical process is to assume that the general public is so impressed by sophisticated procedures that they will readily support any action that is the result of a difficult analysis. Most often the opposite is true. For while they may be impressed with technical competence, they are seldom convinced of the value of improvements that cannot be explained in laymans terms.

What is needed at the end of the initial phases of the continuing process is a series of documents. On one hand the technical data should be presented in such a way that interested persons can determine the basis for the proposed plan and its accompanying assumptions of growth. On the other hand the general public should be provided with a well illustrated summary of the initial phases described with a minimum of technical jargon. It should point out the benefits of the initial phase in terms of actual improvements either in progress or programmed for early completion. It should also be very emphatic about the flexibility of improvement designs based on a twenty year forecast. Finally the continuing nature of the planning process should be emphasized with the use simplified examples.

Only by explaining the purpose and benefits of transportation planning to the general public will effective

cooperation of all jurisdictions be possible. Without such cooperation, the implementation efforts will be greatly handicapped.

CHAPTER XI. THE CONTINUING PROCESS

The 1962 Federal Highway Act, which created the motivation for transportation planning in the smaller urban areas included in its requirements that the planning process be continuing as well as cooperative and comprehensive. This provision reflects the dynamic, ever-changing demands for urban services. In the past too many planning efforts have been directed at solving a problem that existed at a single point in time. The results of such an approach are often referred to as "paper plans," in that they bear little resemblance to the practical, everchanging conditions of the area for which they are prepared. Such plans actually have a negative value in that they are expensive to create but serve no useful purpose. Thus, the planning process, in order to be of practical benefit, must be a continuing appraisal of the needs and how they can be met.

Organization

Once the initial plan preparation cycle of the Study has been completed it is necessary to see that implementation efforts are encouraged and that changing conditions are reflected in the plans.

Council of Governments

The continuing transportation study, in order to be effective, must consist of a formal organization of all of the concerned political jurisdictions. Presently the most effective organization seems to be the council of governments described in Chapter III. It minimizes reorganization of local governments, does not alter their boundaries, nor does it reallocate their functions. Its powers are advisory rather than coercive, but it is in a position to provide the continued concern for the problems of the entire Area.

Agreements

As in the case of the initial Study organization, there must be a legal commitment of participation by each of the concerned agencies. Involved are the personnel commitments for study efforts, financial backing for the continuing program, and administrative involvement in the evaluation and decision process.

Committees

For the most part the guiding committee system established for the initial Study can provide the continuing leadership, especially that of the technical committee. It is most familiar with the assumptions and limitations behind the originally accepted plan and its members are in an ideal position to encourage implementation budgets within their own agencies.

Staff

The staff requirements for the continuing phase of a Study are extremely flexible. The time schedule for revising existing plans and estimates is subject to many interruptions. It is for this reason that the commitments of each agency must be established in the formal agreements. In general, these commitments involve a continual updating of the inventory data and a periodic analysis of the travel demand. Local agencies are in the best position to maintain the inventory files as a part of their existing routines. The SHD is often in a position to maintain the technical analysis capacities by utilizing its personnel on several Studies. The transportation consultant retains the role of advisor and periodic system analyst. His services are required only to appraise the effects of changing growth on the assumptions underlying the analysis, to suggest new and better analysis techniques, and to perform as an analyst when a complete system re-evaluation becomes necessary.

Operation

The history of continuing transportation studies is so brief that it might be better defined as a trial-and-error period. Little in the way of established procedures have evolved until very recently. In May of 1968, BPR issued an instructional memorandum (1968) on the continuing Study. This memorandum attempts to outline a minimal approach to the process without restricting the Studies to a rigid set

of procedures. On one hand there is the need to check forecasts and demands to see if they correspond to the plan. However, on the other hand, there is the realization that this comparison process need not be continuous. Establishing a reasonable schedule that is both adequate and financially acceptable would seem to be the basic problem.

The Southeastern Wisconsin Regional Planning Commission (SEWRPC, 1967) has suggested five elements as being essential to a continuing Study. These elements correspond to those in the BPR memorandum described above.

Surveillance

The inventory of existing land use, population and transportation characteristics provide the basis for the forecasts. Thus, it is imperative to maintain a current estimate of these values to determine whether the forecast estimates continue to remain valid. EDP should be utilized wherever possible to make this task part of the normal operations. For example: the land use files can be updated by recording building permits and zoning changes; population can be adjusted by school enrollment and voter registrations; and traffic characteristics can be monitored by a continuing program of street volume counts, accident analyses, and travel time studies. In each of these cases the data can be updated as a part of the existing responsibilities of the contributing agencies.

Reappraisal

Periodically the plan should be compared with the updated inventory data. This may consist only of adjusting the travel demand to reflect a change in land use by developing revised future trip tables with the calibrated models; it may consist of a recalibration of the models, a new trip table, and a revision of the improvement program to reflect new priorities; or it may consist of a review of the entire travel demand process including community values, economic potential, population, land use analyses, new or recalibrated models, a system evaluation, and a new priority program. The level of activity in each update will be governed by the growth rate of the community. However, it is expected that BPR will issue minimum criteria at each level to assure that each Study continues to maintain critical analysis of its ever changing needs.

Service and Plan Implementation

Planning data can be of little use if it is not made available to the decision makers in a recognizable form. The continuing phase should include as one of its responsibilities to the encouragement of plan implementation, both construction improvements and adequate land use control. This function is one of the justifications for the initial efforts to involve the local technicians. They are in an ideal position to provide support for the yearly budget allocations required to maintain the improvement program and

can evaluate the effects of adverse zoning requests.

Procedural Development

The techniques utilized in the development of the transportation improvement program are all subject to varying degrees of error. One of the objectives of the continuing Study should be to develop more accurate methods. However, as noted in Chapter V, the small urban areas are seldom able to undertake what essentially is a research program. Thus, this phase of most continuing Studies generally will be concerned with adapting the new analysis techniques that are being developed.

Documentation

The efforts of the continuing Study must be made available to all concerned persons if they are to be useful. Thus, it is suggested that one of the phases be concerned with publishing this information in keeping with the discussion in the last three paragraphs of Chapter X. Only by providing a continued documentation of the Study efforts can its initial objectives be achieved.

LIST OF REFERENCES

- American Municipal Association, 1964; American Municipal Association, Developing the Transportation Plan, Chicago, Illinois, Public Administration Service, 1964.
- Ashman, 1963; Ashman, F. T., "The Policy Plan in the Planning Program," Planning 1963, American Society of Planning Officials, 1963.
- Ayad, 1967; Ayad, Hassan, "System Evaluation by the Simplified Porportional Assignment Technique," An unpublished Ph.D. dissertation, Purdue University, June, 1967.
- Ben et al., 1964; Ben, C., Bouchard, R., and Sweet, C., Jr., "An Evaluation of Simplified Procedures for Determining Travel Patterns in a Small Urban Area," Record 88, Highway Research Board, 1964.
- Bolyard, 1965; Bolyard, F. S., "The Role of Indiana in Urban Transportation Planning Studies," Proceedings, 51st Annual Road School, Purdue University, 1965.
- BPR, 1963; Bureau of Public Roads, U. S. Department of Commerce, "Urban Transportation Planning," Instructional Memorandum 50-2-63, March, 1963.
- BPR, 1964a; Bureau of Public Roads, U. S. Department of Commerce, Traffic Assignment Manual, Washington, D. C., U. S. Government Printing Office, 1964.
- BPR, 1964b; Bureau of Public Roads, U. S. Department of Commerce, Population Forecasting Methods, June, 1964.
- BPR, 1965a; Bureau of Public Roads, U. S. Department of Commerce, The Role of Economic Studies in Urban Transportation Planning, Washington, D. C., U. S. Government Printing Office, 1965.
- BPR, 1965b; Bureau of Public Roads, U. S. Department of Commerce, Calibrating and Testing a Gravity Model for Any Size Urban Area, Washington, D. C., U. S. Government Printing Office, 1965.
- BPR, 1967a; Bureau of Public Roads, U. S. Department of Transportation, "Urban Transportation Planning," Policy and Memorandum 50-9, June 1967.

- BPR, 1967b; Bureau of Public Roads, U. S. Department of Transportation, Guidelines for Trip Generation Analysis Washington, D. C., U. S. Government Printing Office, 1967.
- BPR, 1967c; Bureau of Public Roads, U. S. Department of Transportation, Estimating Transit Usage (Modal Split), Washington, D. C., 1967.
- BPR, 1968; Bureau of Public Roads, U. S. Department of Transportation, "Operating Plans for Continuing Urban Transportation Planning," Instructional Memorandum 50-4-68, May, 1968.
- Chicago Area Transportation Study, 1960; Chicago Area Transportation Study, Volume II, July 1960.
- Cowdery, 1962; Cowdery, R. C., "Transportation Planning in Small Communities," Traffic Quarterly, Volume 26, January 1962.
- Deen, 1966; Deen, T. A., Discussion of: "Criteria for Evaluating Alternative Transportation System," Record 148, Highway Research Board, 1966.
- Ferguson, 1966; Ferguson, G. A., "Development of Transportation System Alternatives," Record 148, Highway Research Board, 1966.
- Fratat, 1954; Fratar, T. J., "Forecasting Distribution of Interzonal Vehicular Trips by Successive Approximations," Proceedings, Highway Research Board, Volume 33, 1954.
- Gakenheimer, 1964; Gakenheimer, R. A., "Planning, Transportation, and the Small City," Traffic Quarterly, Volume 28, April 1964.
- George and Pyers, 1964; George, S., Jr., and Pyers, C..E., "Applications of Critical Path Programming to Large-Scale Transportation Studies," News, Number 12, Highway Research Board, June 1964.
- Grecco, 1963; Grecco, W. L., "The Continuing Transportation Study for the Small City," Proceedings, 49th Annual Road School, Purdue University, 1963.
- Hanson, 1966; Hanson, R., Metropolitan Councils of Governments, Report M32, Washington, D. C., U. S. Government Printing Office, 1966.
- Hamburg, 1966; Hamburg, J., Discussion of: "Development of Transportation System Alternatives," Record 148, Highway Research Board, 1966.

- Hatt and Reiss, 1951; Hatt, P. K., and Reiss, A. J., Cities and Society, The Free Press, 1951.
- Heanue and Pyers, 1965; Heanue, K. and Pyers, C., "A Comparative Evaluation of Trip Distribution Procedures," Record 114, Highway Research Board, 1965.
- House Document 379, 1944; House Document 379, "Interregional Highways," 78th Congress, 1944.
- HUD, 1965; Bureau of Public Roads and Department of Housing and Urban Development, Standard Land Use Coding Manual, Washington, D. C., U. S. Government Printing Office, 1965.
- Jefferies, 1968; Jefferies, W. R. and Carter, E. C., "Simplified Techniques for Developing Transportation Plans - Trip Generation in Small Urban Areas," Paper presented at the 47th Annual Highway Research Board Meeting, January 1968.
- Jorgensen, 1965; Jorgensen, R. E., "Deficiencies in Urban Transportation Studies," Journal of the Highway Division, American Society of Civil Engineers, Vol. 91, No. HW2, Dec. 1965.
- Leiper, 1966; Leiper, J. M., Discussion of: "Criteria for Evaluating Alternative Transportation Systems," Record 148, Highway Research Board, 1966.
- Martin, Memmott, and Bone, 1961; Martin, B. V., Memmott, F. W., and Bone, A. J., Principles and Techniques of Predicting Future Demand for Urban Area Transportation, Research Report 38, Massachusetts Institute of Technology, Cambridge, Massachusetts, June 1961.
- Matthewson, 1966; Matthewson, Kent, "Planning and Decision-Making in the Detroit Metropolitan Area," Record 137, Highway Research Board, 1966.
- Maxman, 1968; Maxman, R. J., "Development of the Environmental Data Storage and Retrieval System," An unpublished M. S. thesis, Purdue University, March 1968.
- Mitchell and Rapkin, 1954; Mitchell, R. B. and Rapkin, C., Urban Traffic, A Function of Land Use, New York, Columbia University Press, 1954.
- NCUT, 1958; National Committee on Urban Transportation, Better Transportation For Your City, Chicago, Illinois, Public Administration Service, 1958.

_____; National Committee on Urban Transportation,
Procedural Manuals:

- 1A Determining Street Use
- 2A Origin-Destination and Land Use
- 2B Conducting a Home Interview Origin-Destination Survey
- 3A Measuring Traffic Volumes
- 3B Determining Travel Time
- 3C Conducting A Limited Parking Study
- 3D Conducting a Comprehensive Parking Study
- 3E Maintaining Accident Records
- 4A Measuring Transit Service
- 5A Inventory of the Physical Street System
- 6A Financial Records and Reports
- 6B Cost Accounting
- 7A Standards for Street Facilities and Services
- 8A Standards for Transit Facilities and Services
- 10A Establishing Project Priorities
- 11A Improving Transportation Administration
- 12A Modernizing Laws and Ordinances

Office of the Vice President, 1967; Office of the Vice President, The Vice President's Handbook for Local Officials - A Guide to Federal Assistance for Local Governments, Washington, D. C., U. S. Government Printing Office, November 1967.

Ruiter, 1967; Ruiter, E., "Improvements in Understanding, Calibrating, and Applying the Opportunity Model," Record 165, Highway Research Board, 1967.

Schimpeler, 1967; Schimpeler, C. C., "A Decision Theoretic Approach to Weighting Community Development Criteria and Evaluating Alternative Plans," Unpublished Ph.D. dissertation, Purdue University, August, 1967.

Schmidt and Campbell, 1956; Schmidt, R. E., Campbell, M. E., Highway Traffic Estimation, ENO Foundation, Sangatuck, Connecticut, 1956.

Shunk, 1967; Shunk, G. A., "The Journey to Work: A Singular Basis for Travel Pattern Surveys," An unpublished Ph.D. dissertation, Purdue University, 1967.

Smith, 1967; Smith, W. S., "Manual on Urban Planning, Chapter VII: Transportation Planning," Journal of the Urban Planning and Development Division, American Society of Civil Engineers, Volume 93, Number UP4, December, 1967.

Sosslau and Brokke, 1960; Sosslau, A. B. and Brokke, G. E., "Appraisal of Sample Size Based on the Phoenix O & D," Bulletin 253, Highway Research Board, 1960.

SEWRPC, 1967; Southeastern Wisconsin Regional Planning Commission, Newsletter, Volume 7, Number 4, 1967.

Stewart, 1968; Stewart, W. D., "An Urban Area Use Model to Maximize Return," An unpublished Ph.D. dissertation, Purdue University, 1968.

Vogt-Ivers & Associates, 1966; Vogt-Ivers and Associates, Ohio Procedural Manuals, (Volumes 1 through 9), Cincinnati, Ohio, 1966.

Voorhees, 1955; Voorhees, A. M., "A General Theory of Traffic Movement," Proceedings, Institute of Traffic Engineers, 1955.

Walker, 1968; Walker, J. R., "A Procedure for Determining Future Trip Ends," Paper presented at the 47th Annual Highway Research Board Meeting, January 1968.

Williamsburg Conference, 1965; American Association of State Highway Officials, Report on the Second National Conference on Highways and Urban Development (Williamsburg, Va., 1965).

Wynn and Levinson, 1967; Wynn, F. H. and Levinson, H. S., "Some Considerations in Appraising Bus Transit Potentials," Record 197, Highway Research Board, 1967.

Zettel and Carll, 1962; Zettel, R. M. and Carll, R. R., "Summary Review of Major Metropolitan Area Transportation Studies in the United States," Special Report, Institute of Transportation and Traffic Engineering, University of California, Berkeley, California, November 1962.

APPENDIX A

Sample Activity Sequence Diagram

The following diagram is an example of a CPM flow chart that would be prepared as part of a transportation study design. The activity sequence numbers are coded to the listing in Appendix B.

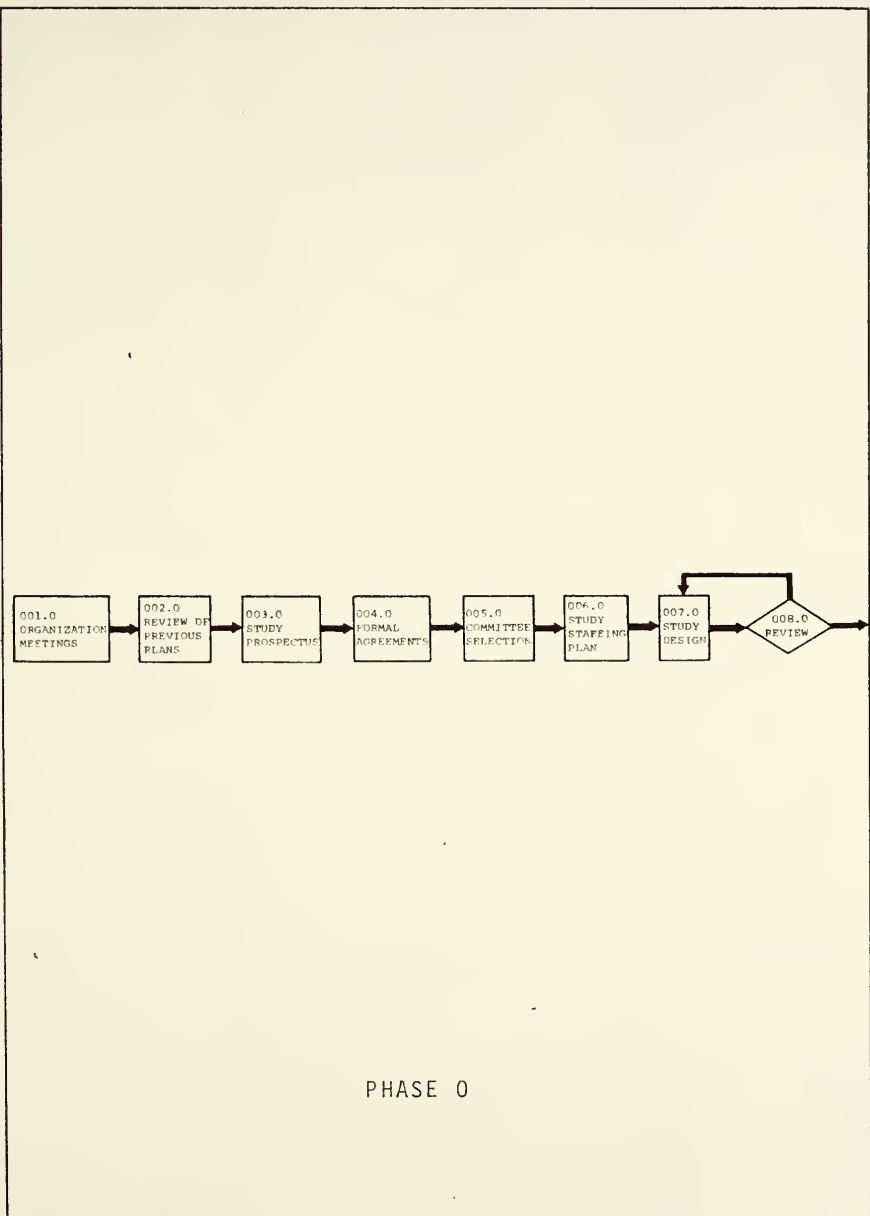


Figure A-1. Sample Activity Sequence Diagram.

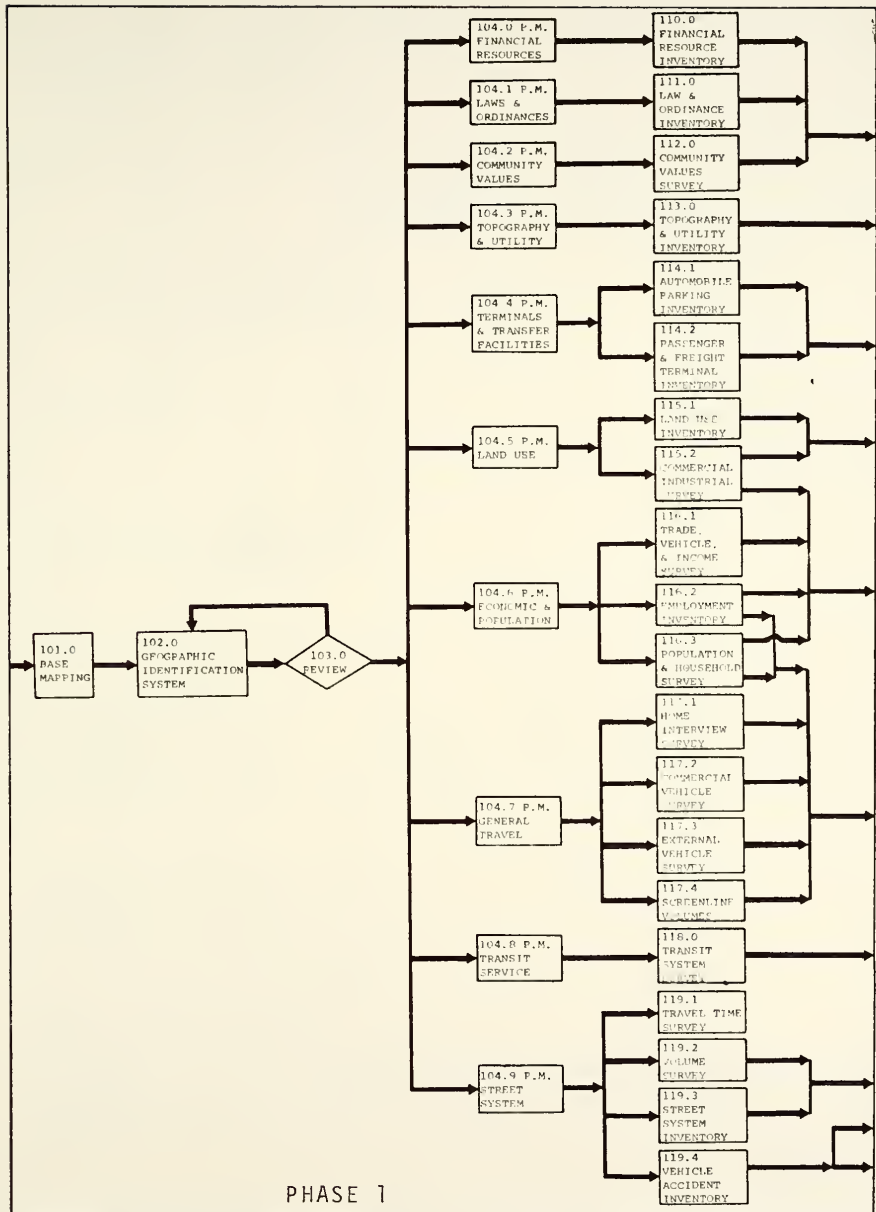


Figure A-1. Continued.

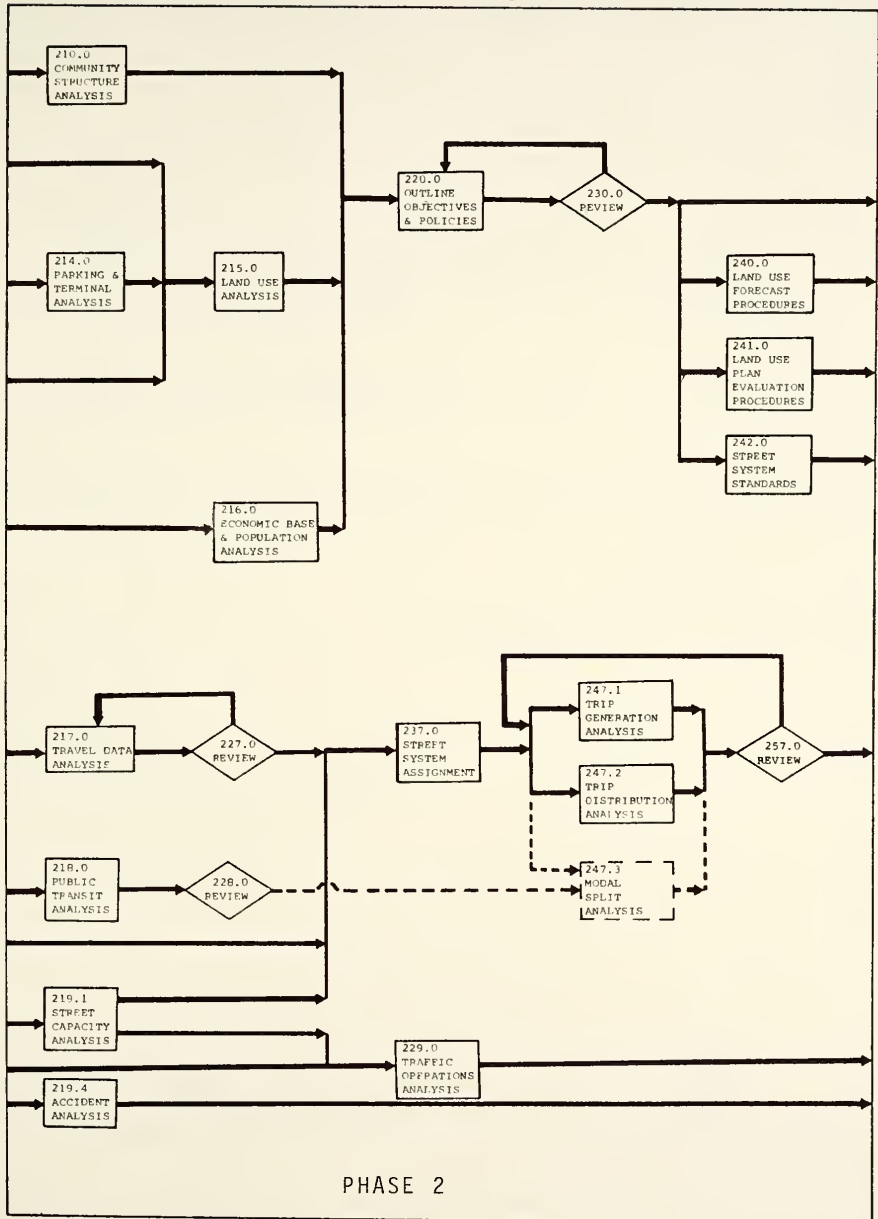


Figure A-1. Continued.

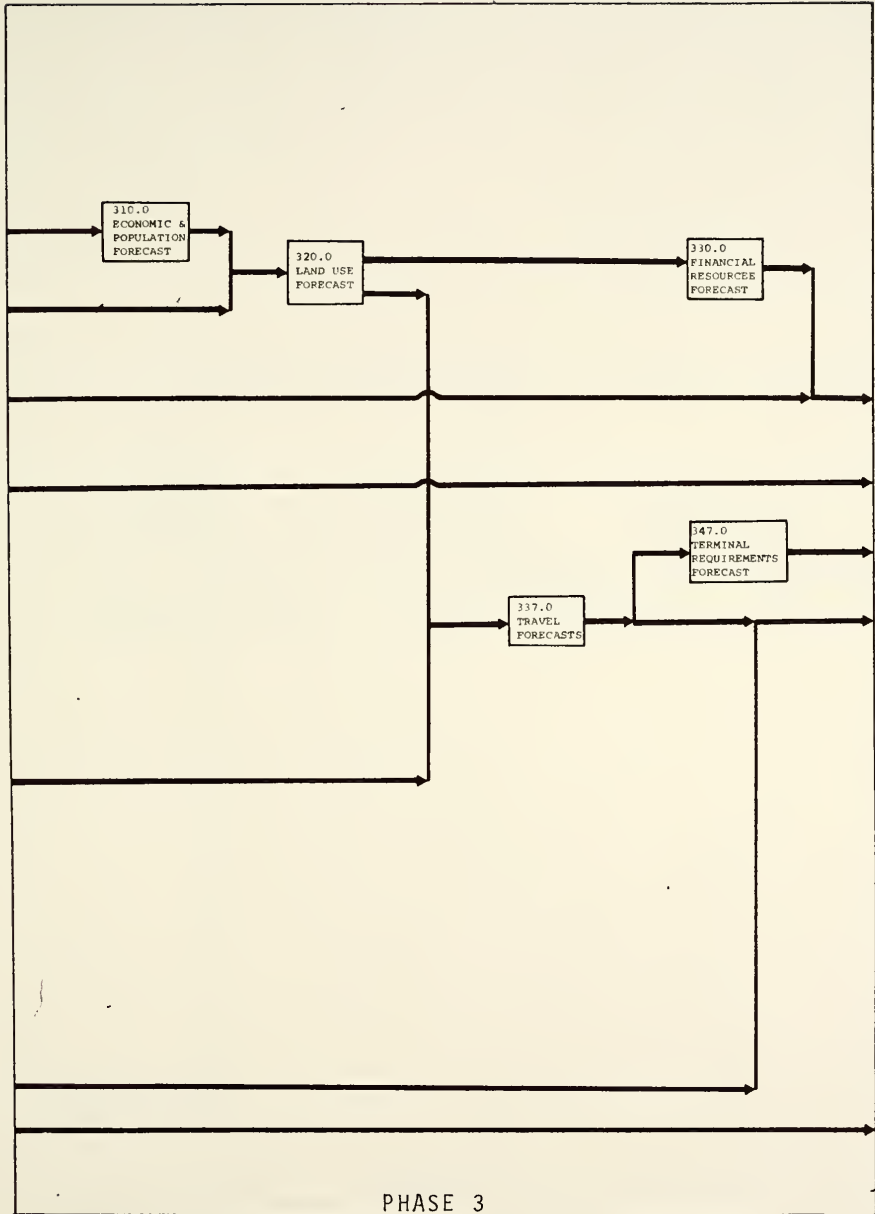


Figure A-1. Continued.

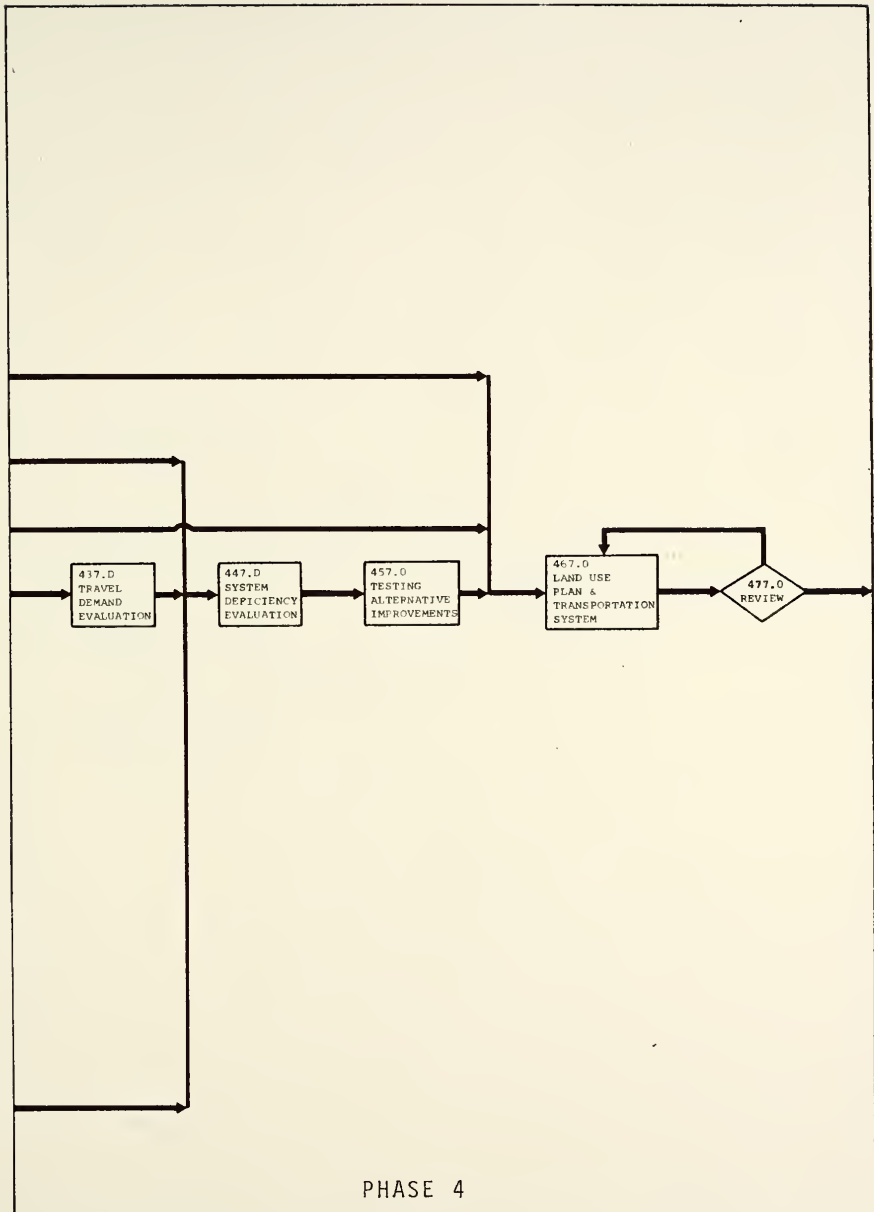


Figure A-1. Continued.

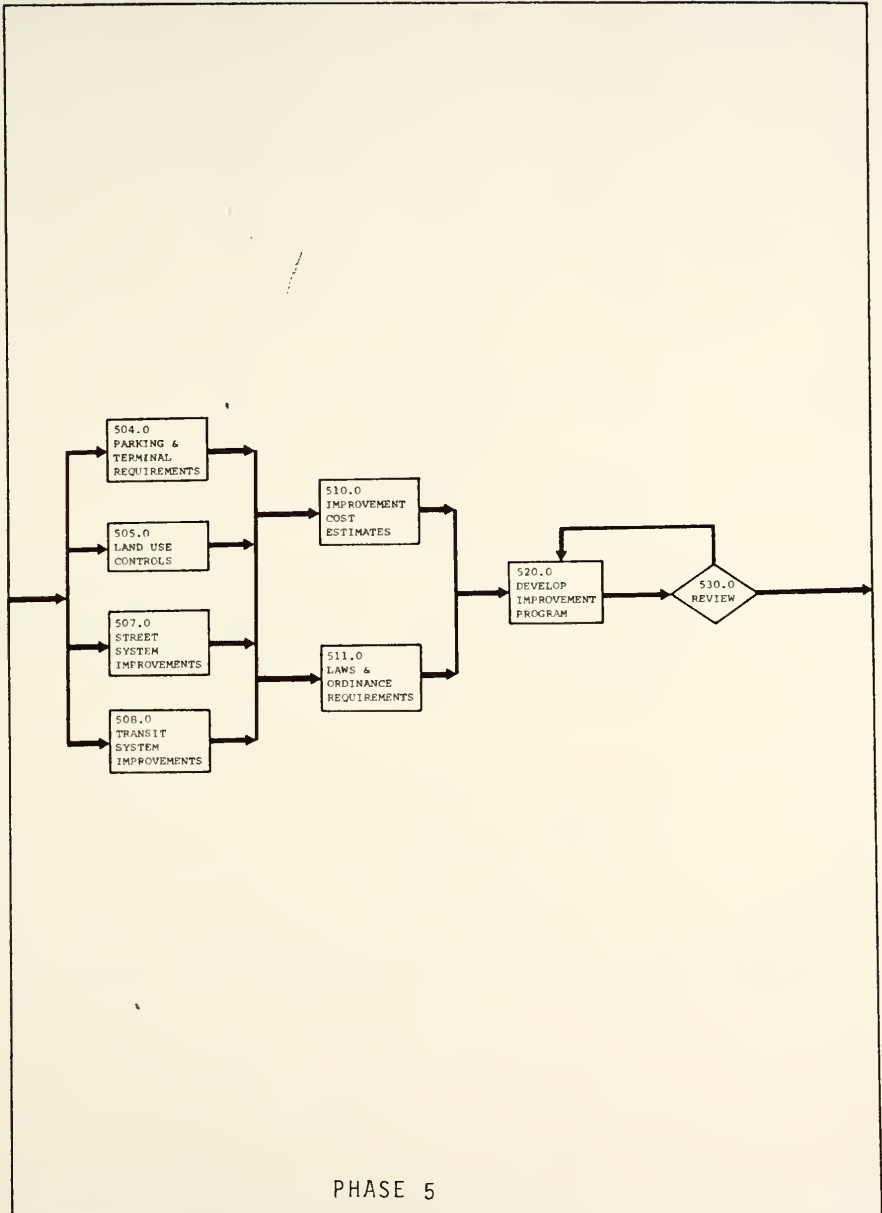


Figure A-1. Continued.

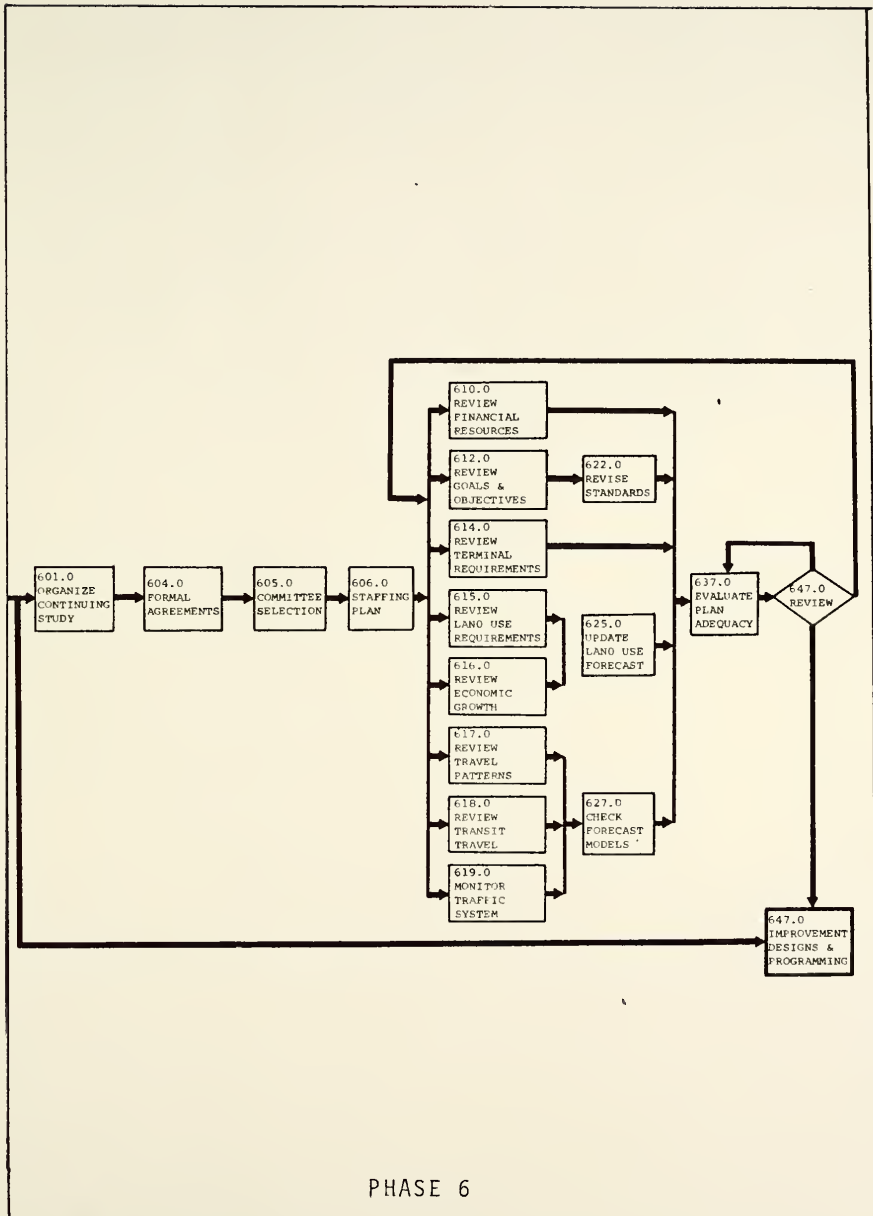


Figure A-1. Continued.

APPENDIX B

Sample Activity Descriptions

The following activity descriptions are examples of the descriptions that would be prepared as part of a transportation study design. The activity sequence numbers are coded to the sample CPM flow chart shown in Appendix A.

001.0 - ORGANIZATION MEETINGS

Purpose: Initial contact of all potentially concerned agencies including: BPR, HUD, SHD, county(s), city(s), area planning commission, and the various improvement districts; describes the need for transportation planning based on the importance of the role of the transportation system in the urban area and the restrictions on Federal Aid monies for urban improvements.

Dependencies: None

Output: Activity descriptions and sequences necessary to prepared input for the Study design. These include: reviewing previous planning efforts, preparation of a prospectus, development of formal agency agreements, committee selection, and Study staffing.

002.0 - REVIEW OF PREVIOUS PLANS

Purpose: Provides a source of existing data on growth and development of the area; includes the ideas and goals of previously instituted planning efforts; reflects on the history of the area's attitude toward implementing planning programs.

Dependencies: #001.0, planning reports available from local and state agencies, and historical descriptions of the effects of planning on community growth.

Output: Existing plans considered to be in keeping with the general growth of the area; and planning data collected by the previous studies.

003.0 - STUDY PROSPECTUS

Purpose: To describe the purpose and scope of the Study, the geographical limits of the area, and political jurisdictions included.

Dependencies: #002.0, general jurisdictional and highway maps, and required population data (U. S. Census).

Output: A formal document that describes the need for the Study, the political jurisdictions and agencies included within a defined study area, the general scope of a transportation study, and proposed method of establishing a committee system and a staff to operate the Study. At this point it is also advisable to begin a formal program of public information releases to advise the interested public.

004.0 - FORMAL AGREEMENTS

Purpose: To establish a set of legal agreements among the participating agencies. Provides a basis for financial contributions as well as a commitment to cooperate in the planning process as required for Federal Aid participation.

Dependencies: #003.0 and legal opinions on the contracts.

Output: The signed documents and any revisions to the prospectus.

005.0 - COMMITTEE SELECTION

Purpose: To establish the policy, technical, and citizens advisory committees that will provide the necessary guidance to the Study process.

Dependencies: #004.0.

Output: The organized committee system with defined channels of communication, authority, and responsibilities.

006.0 - STUDY STAFFING PLAN

Purpose: To develop the most feasible staffing plan to accomplish the objectives of the Study as set forth in the Prospectus.

Dependencies: #005.0, the technical capabilities of available local agency personnel, the time commitments for these technicians, and a policy decision on the use of professional consultants.

Output: The staffing plan, including a prospectus for professional services if a consultant is to be retained for all or separate phases of the Study.

007.0 - STUDY DESIGN

Purpose: To develop a detailed operations plan or work program, including description of activities, time schedules, budget allocations, designation of agency responsibilities, and the end products required

Dependencies: #006.0, budget commitments from cooperating agencies, a review of feasible planning techniques.

Output: A detailed work schedule described by a CPM diagram and individual activity descriptions including the separate work items.

008.0 - REVIEW

Purpose: To allow the policy committee to review the proposed design with relation to the Study objectives and the implications of time and budget considerations. It also provides an opportunity for BPR and HUD to decide whether the design will fulfill the minimum qualifications for Federal Aid participation in the Study.

Dependencies: #007.0, and the establishment of proper review channels for BPR and HUD.

Output: An acceptable study design and a formal documentation of the design.

101.0 - BASE MAPPING

Purpose: To develop area-wide maps that are current and adequate for completion and coding of the required inventory data and analysis of urban growth and travel demand.

Dependencies: #008.0, existing maps of the area from U.S.G.S., the SHD, the county(s), the city(s), and the various utility companies.

Output: Current base maps at various appropriate scales covering the Study Area.

102.0 - GEOGRAPHIC IDENTIFICATION SYSTEMS

Purpose: To develop coding systems for travel inventory data, land use data, and population characteristics.

Dependencies: #101.0, available street address directories, utility company records, U. S. Census tract and enumeration data, existing planning subdivisions such as neighborhoods, and recent street traffic volume maps.

Output: A selected street system functionally classified as freeway, arterial, and collector; a land use identification system by parcel, block, or inventory zone; and a dwelling unit identification system by street address within the inventory zone.

103.0 - REVIEW

Purpose: To allow the policy committee to review the proposed coding systems and decide on the detail level of coding that will be adequate within the framework of the Study budget; also allows BPR to review adequacy of the zoning and HUD the adequacy of land use coding systems as they concern future uses of the data.

Dependencies: #102.0

Output: Established coding systems as recommended by the policy committee, BPR, and HUD.

104.0, 1,2,3,4,5,6,7,8,9 - PROCEDURAL OUTLINES OF THE GENERAL INVENTORY

Purpose: To develop the procedures that are to be used in each phase of the inventory and develop the descriptive manuals to be used by the Study Staff during the inventory phase. These manuals also serve as documentation of the procedures.

Dependencies: #103.0

Output: Procedural manuals for inventory of:

- 104.0 financial resources
- 104.1 laws and ordinances
- 104.2 community values
- 104.3 topography and utilities
- 104.4 terminals and transfer facilities
- 104.5 land use
- 104.6 economic base and population
- 104.7 general travel
- 104.8 transit service
- 104.9 street system

110.0 - FINANCIAL RESOURCES INVENTORY

Purpose: To determine the history and present status of the financial resources of the participating agencies, and that portion of the resources that has been available for financing the transportation system.

Dependencies: #104.0, and historical records of all participating agencies' financial commitments.

Output: Tabulation of the annual transportation-related expenditures and percent of total expenditures for each of the agencies, and including a breakdown as to what percent of each was contributed by the Federal Government.

111.0 - LAW AND ORDINANCES INVENTORY

Purpose: To determine the history of taxation policies, land use ordinances (zoning), and public expenditure legislation (public works, improvement bonds) of each of the participating agencies.

Dependencies: #104.1, historical records of the laws and ordinance legislation of each of the participating political jurisdictions.

Output: Chronological history of legislative acts related to taxation, zoning, and public expenditures.

112.0 - COMMUNITY VALUES SURVEY

Purpose: To develop a history of the evolution of recreational facilities (parks, open space), school districts, neighborhoods, historical sites and buildings, and other organized community efforts that encouraged the preservation and enhancement of the urban environment.

Dependencies: #104.2 and local history of community improvement efforts.

Output: Annotated history of community improvement efforts, with an emphasis on the attitudes that prevailed and the persons who were primarily responsible for fostering the attitudes.

113.0 - TOPOGRAPHY AND UTILITY INVENTORY

Purpose: To develop a graphical representation of the topographic relief (slope of the ground and general soil conditions) and the location and capacities of existing public utilities (sewer, water, and electric power).

Dependencies: #104.3, utility company records and maps, and topographic data from local agencies and U.S.G.S.

Output: General topographic maps, soils maps, utility location maps, and a tabulation of the history of the demand versus capacity of each utility service.

114.1 - AUTO PARKING INVENTORY

Purpose: To determine the locations quantity, type, and average daily use of existing parking facilities within the urban area.

Dependencies: #104.4.

Output: Parking data coded to the land use parcel identification system.

114.2 - PASSENGER AND FREIGHT TERMINAL INVENTORY

Purpose: To determine the location, numbers of passengers, and sizes of air, rail, and intercity bus passenger terminals; and to determine the location, freight quantities, and physical capacities of the air, rail, and water freight terminals.

Dependencies: #104.4, and commercial freight and passenger records of common carriers operating in the area.

Output: Passenger and freight terminal data coded to the land use parcel identification system.

115.1 - LAND USE INVENTORY

Purpose: To develop a tabulation of the types and intensities of land uses coded to the land use parcel identification system.

Dependencies: #104.5

Output: Tables of land use data classified by type and intensity.

115.2 - COMMERCIAL-INDUSTRIAL SURVEY

Purpose: To provide an extensive review of present land use practices of major commercial and industrial firms and to determine anticipated future development land requirements of these firms.

Dependencies: #104.5, and identification of major commercial and industrial firms and liaison contacts through the Citizens Advisory Committee to assure cooperation by their firms.

Output: Commercial and industrial land use maps, general land use classification data for activity 115.1, and information on economic outlook for use in economic base and land use forecasts.

116.1 - TRADE, VEHICLE, AND INCOME SURVEY

Purpose: To establish historical trends in the growth and fluctuations in retail trade, vehicle ownership, and personal income.

Dependencies: #104.6, U. S. Census data, and state and local vehicle registration records and retail sales data.

Output: Tabular trends in sales, vehicle registrations, and personal income by state, county(s), municipalities, and census tracts where available.

116.2 - EMPLOYMENT INVENTORY

Purpose: To determine the locations and industrial classifications of employment in the Study Area, and to establish historical trends in the labor demand.

Dependencies: #104.6, state and local agency employment records, and local employer cooperation obtained by the Citizens Advisory Committee.

Output: Employment tabulations by standard industrial code (S.I.C.) for state, county, municipality, and census tract (where possible).

116.3 - POPULATION AND HOUSEHOLDS SURVEY

Purpose: To establish a measure of the total number and area-wide distribution of the current population and households in the Study Area.

Dependencies: #104.6, local planning data, and U. S. Census data on block statistics (limited to tracts in some areas).

Output: Tabulations of population and households in the county(s), municipalities, U. S. Census tracts, and census blocks where available.

117.1 - HOME INTERVIEW SURVEY

Purpose: To obtain a representative sample of the daily trips (origin and destination addresses, mode of travel, and trip purpose) made by the residents of the Area during an average week day; and information on household characteristics such as family size, occupations, auto ownership, and personal income.

Dependencies: #104.7, and identification of all dwelling units within the Area.

Output: An expanded tabulation of the trip origins, destinations, purposes, travel mode, and time of day, coded to the inventory zones; also a tabulation of the household characteristics of each inventory zone.

117.2 - COMMERCIAL VEHICLE SURVEY

Purpose: To obtain a representative sample of the daily trips made by the trucks, taxis, and rental vehicles operating in the Area.

Dependencies: #104.7, and listing of commercial vehicles operating in the Area.

Output: An expanded tabulation of the trip origins, destinations purposes, and time of day, coded to the inventory zones.

117.3 - EXTERNAL VEHICLE SURVEY

Purpose: To obtain a representative sample of the daily trips that enter or leave the Area.

Dependencies: #104.7, and the establishment of cordon interview stations on highways crossing the Study boundaries.

Output: An expanded tabulation of the trip origins, destinations, purposes, and time of day, coded to the inventory zones and cordon stations.

117.4 - SCREENLINE VOLUMES

Purpose: To establish volume counts of actual vehicle movements occurring during the sample surveys.

Dependencies: #104.7

Output: A tabulation of vehicle volumes by time of day for selected links of the street system.

118.0 - TRANSIT SYSTEM SURVEY

Purpose: To establish the availability and use of existing public transit within the Area.

Dependencies: #104.8 and time schedules and passenger loading data from transit companies.

Output: A tabulation of the transit routes and passenger volumes coded to the selected street system.

119.1 - TRAVEL TIME SURVEY

Purpose: To establish average travel speeds on the selected street system by time of day.

Dependencies: #104.9.

Output: A tabulation of average travel speed by time of day coded to each link of the selected street system.

119.2 - VOLUME SURVEY

Purpose: To establish average daily vehicle traffic volumes on each of the links in the selected street system and the variations in these volumes by time of day.

Dependencies: #104.9, and historical street volume data.

Output: A tabulation of the daily vehicle volumes and peak hour percentage of this volume for each link of the selected system.

119.3 - STREET SYSTEM INVENTORY

Purpose: To establish a coded record of the physical dimensions (street width, number of lanes, etc.) of the links and the traffic control (stop signs, signals, etc.) of each of the nodes of the selected street system.

Dependencies: #104.9.

Output: A tabulation of the physical dimensions of the links and traffic control at each node of the coded street system.

119.4 - VEHICLE ACCIDENT INVENTORY

Purpose: To establish a coded record of vehicle accidents by location and type.

Dependencies: #104.9, and historical accident records from city, county, and state police files.

Output: A tabulation of accident data by location and type coded to the selected street system.

210.0 - COMMUNITY STRUCTURE ANALYSIS

Purpose: To establish trends in the availability of financial support for community improvements; the laws which control taxation policies and zoning ordinances; and the organized efforts of the citizens to provide for adequate educational facilities, cultural centers, recreational areas, urban renewal programs, and other programs directed at improving and preserving the urban environment.

Dependencies: #110.0, 111.0, and 112.0.

Output: A description of the past achievements of the community, including discussions which relate motivation forces (local interest, state law, Federal restrictions) to the success of the various improvement programs.

214.0 - PARKING AND TERMINAL ANALYSIS

Purpose: To establish present availability, utilization, and coordination of vehicle, passenger, and freight terminals within the Area.

Dependencies: #114.1 and 114.2.

Output: A description of present terminal practices, their adequacy, and anticipated changes in operating policies of the parking programs, intercity passenger service, and freight handling, storage, and distribution.

215.0 - LAND USE ANALYSIS

Purpose: To establish trends and patterns of existing land utilization in the Area.

Dependencies: #113.0, 115.1, 115.2, and 214.0.

Output: A description of the present pattern of land utilization and the availability and suitability of land for future development.

216.0 - ECONOMIC BASE AND POPULATION ANALYSIS

Purpose: To identify the existing economic base of the Area; to identify the economic growth potential of the Area and the accompanying increase in employment; and to establish trends in population: totals, age distribution, educational levels, personal income, and percent in the labor force.

Dependencies: #115.2, 116.1, 116.2, and 116.3.

Output: A description of the present economic base and its supporting population.

217.0 - TRAVEL DATA ANALYSIS

Purpose: To compare data acquired by expanding the sample interviews with employment, population and vehicle trip movements determined by separate independent measurements.

Dependencies: #116.2, 116.3, 117.1, 117.2, 117.3, and 117.4.

Output: Comparisons of work trip destinations with employment, sample estimates of population with census data, and sample estimates of travel across natural barriers (rivers, railroad tracks, etc.) with volume counts on these crossing links.

218.0 - PUBLIC TRANSIT ANALYSIS

Purpose: To analyze the effectiveness of available public transit in order to determine whether it constitutes sufficient trips to warrant including a mode selection analysis and forecast; also to establish a set of transit trip data suitable for a separate transit study.

Dependencies: #118.0 and 227.0.

Output: A tabulation of the effect of transit trips on the street system in the form of zone-to-zone trip tables.

219.1 - STREET CAPACITY ANALYSIS

Purpose: To determine the existing street utilization by comparing volume estimates to the potential capacity of each of the links in the street system.

Dependencies: #119.2, 119.3.

Output: A tabulation of volume and capacity for each link of the selected street system.

219.4 - ACCIDENT ANALYSIS

Purpose: To establish general trends in accident experiences by functional class of street in order to determine the expected increase in safety and resulting economic benefit of a particular type of street improvement (i.e., providing medians on an arterial).

Dependencies: #119.4.

Output: Tabulations of accident types by class of street and expected changes in accident experiences for various feasible street improvements.

220.0 - OUTLINE OBJECTIVES AND POLICIES

Purpose: To develop a procedure that can be used to establish a framework of goals and objectives for future development of the Area.

Dependencies: #210.0, 215.0, 216.0

Output: Alternative objectives and accompanying policies that could be used to evaluate the relative merits of various types of transportation system improvements.

227.0 - REVIEW

Purpose: To determine whether the sample data is satisfactory; whether adjustments of the data are required; or whether additional data collection is necessary.

Dependencies: #217.0.

Output: Adjusted tabulations of travel movement estimates by trip purpose and mode of travel in a coded format suitable for use in development of the forecast models.

228.0 - REVIEW

Purpose: To formulate a policy decision on the role of transit in the Study.

Dependencies: #218.0.

Output: A policy on the role of transit in the Study and a tabulation of the coded transit system and the transit trips from the travel inventory for use in a separate public transit study.

229.0 - TRAFFIC OPERATIONS ANALYSIS

Purpose: To determine existing major deficiencies in the street system and propose corrective measures.

Dependencies: #119.4, 219.1, and existing city, county and SHD standards for acceptable levels of service for urban streets.

Output: Tabulation of existing deficiencies and suggested means for their elimination or reduction.

230.0 - REVIEW

Purpose: To allow policy committee, with the advice and aid of the citizens advisory committee, to select the general goals of the community, the objectives that will achieve these goals, and the policy decisions necessary to obtain the objectives.

Dependencies: #220.0.

Output: A set of community goals and objectives along with a series of policy statements.

237.0 - STREET SYSTEM ASSIGNMENT

Purpose: To compare the assignment of the inventory trips to the street system with the volume estimates obtained in volume counting survey and make adjustments where necessary.

Dependencies: #119.1, 219.1, 227.0, and an "Assignment Model."

Output: Street system link travel speeds and capacities coded for use in distribution model calibration.

240.0 - LAND USE FORECAST PROCEDURES

Purpose: To develop an operational procedure that will aid in selecting land growth patterns constrained by the policy decisions.

Dependencies: #230.0.

Output: An operational procedure for allocating the land use demands reflected in the forecast of economic growth.

241.0 - LAND USE PLAN EVALUATION PROCEDURES

Purpose: To develop procedures which can be used to measure which of the land use plans best fosters the overall goals and objectives of the community.

Dependencies: #230.0.

Output: An operational procedure for evaluating the effects of the land use plans on the goals of the community.

242.0 - STREET SYSTEM STANDARDS

Purpose: To establish a minimum acceptable level of service (travel speed, safety, volume-capacity ratio) for each functional class of street.

Dependencies: #230.0.

Output: A tabulation of minimum level of service for each street classification.

247.1 - TRIP GENERATION ANALYSIS

Purpose: To develop models for forecasting zonal trip generation within the Area.

Dependencies: #115.2 and 227.0.

Output: A set of calibrated trip generation models.

247.2 - TRIP DISTRIBUTION ANALYSIS

Purpose: To develop models for predicting the distribution of the trip from the generation forecast.

Dependencies: #237.0 and a "Distribution Model."

Output: A set of calibrated distribution models.

247.3 - MODAL SPLIT ANALYSIS (Use depends on decision in #228.0)

Purpose: To develop models for predicting the percent of the generated trips that will use a transit system.

Dependencies: #115.2 and 228.0.

Output: A set of calibrated modal split models.

257.0 - REVIEW

Purpose: To determine whether the calibrated models are considered adequate for use as travel forecasting tools.

Dependencies: #247.1, 247.2, 247.3.

Output: A set of generation, modal split, and distribution models.

310.0 - ECONOMIC AND POPULATION FORECAST

Purpose: To forecast the growth of the general economy of the Area, the accompanying population growth, increase in retail trade, and land requirements.

Dependencies: #230.0.

Output: Tabulations of population growth, employment growth, retail sales increases, and land requirements to sustain the growth.

320.0 - LAND USE FORECASTS

Purpose: To forecast alternative land use growth patterns that will adequately serve the needs of the economic growth forecast.

Dependencies: #240 and 310.

Output: Alternate land use plans (usually less than three) including type and intensity of use for the entire Area.

330.0 - FINANCIAL RESOURCE FORECASTS

Purpose: To forecast the tax revenues (user, property, and personal) that would be realized by each of the alternative land use forecasts.

Dependencies: #320.

Output: Tabulated revenues from sales, income, and property tax for each land use alternative.

337.0 - TRAVEL FORECASTS

Purpose: To forecast the travel demand of each of the alternative land use forecasts.

Dependencies: #257 and 320.

Output: Tabulated trip tables by purpose for each land use forecast.

347.0 - TERMINAL REQUIREMENTS FORECAST

Purpose: To determine the requirements for auto parking, freight handling facilities and passenger terminals created by the forecast growth and land use patterns.

Dependencies: #337.0.

Output: Tabulated terminal requirements for each land use forecast.

437.0 - TRAVEL DEMAND EVALUATION

Purpose: To develop a travel pattern of forecast trips on the existing street system for each of the land use forecasts.

Dependencies: #229.0 and 337.0.

Output: Tabulated volume assignments for each link in the system.

447.0 - SYSTEM DEFICIENCIES EVALUATION

Purpose: To identify those parts of the street system that are inadequate for the forecast travel demands.

Dependencies: #219.4, 242.0 and 437.0.

Output: Tabulated deficiencies of street capacity by general travel corridors.

457.0 - TESTING ALTERNATIVE IMPROVEMENTS

Purpose: To select alternate improvements to the present system (street widening, freeway construction, increased mass transit, etc.) and test the effectiveness of these improvements on the travel demands (safety, congestion, etc.).

Dependencies: #447.0.

Output: Technically feasible alternate improvement plans that would adequately serve the forecast demand of each of the land use plans; and an evaluation of the effects of each of the improvements on the land use plans.

467.0 - LAND USE PLAN AND TRANSPORTATION SYSTEM

Purpose: To select the land use plan and transportation system which most nearly encourage the type of urban development that is reflected in the goals and objectives as established through the efforts of the Citizens Advisory Committee.

Dependencies: #241.0, 330.0, and 457.0.

Output: Suggested land use plan and accompanying transportation system to serve the forecast growth of the Area.

447.0 - REVIEW

Purpose: To allow the policy committee to review the selection and justifications of activity 467.0, suggest changes and additional evaluations, and to make the final plan selection.

Dependencies: #467.0.

Output: The selected land use and transportation plan.

504.0 - PARKING AND TERMINAL REQUIREMENTS

Purpose: To determine the amount and general locations of additional automobile parking requirements, the pattern of freight transfer, the requirements of air and rail passenger terminals, and the general locations and land requirements of each.

Dependencies: #477.0.

Output: Tabulated terminal requirements and locational maps with potential sites.

505.0 - LAND USE CONTROLS

Purpose: To determine the land use changes and zoning requirements necessary to achieve the selected plan.

Dependencies: #477.0.

Output: Tabulations of land uses, changes, and non-conforming uses that will affect the selected plan.

507.0 - STREET SYSTEM IMPROVEMENTS

Purpose: To determine the physical construction required to achieve the street improvements in the selected transportation plan.

Dependencies: #477.0.

Output: Maps and tabulations of physical construction requirements for the proposed street system.

508.0 - TRANSIT SYSTEM IMPROVEMENTS

Purpose: To determine the physical construction required to achieve the transit improvements in the selected transportation plan.

Dependencies: #477.0.

Output: Maps and tabulations of physical construction and equipment requirements for the proposed transit system.

510.0 - IMPROVEMENT COST ESTIMATES

Purpose: To determine the cost of providing the street and transit improvements.

Dependencies: #504.0, 505, 0, 507, 0, and 508.0.

Output: Tabulations of costs of providing each of the required improvements as well as a tabulation of yearly revenue available to support the improvement program.

511.0 - LAW AND ORDINANCE REQUIREMENTS

Purpose: To determine changes and modifications in the legal structure required to assure an orderly land use pattern and adequate financing of the improvement program.

Dependencies: \$504.0, 505, 0, 507, 0, and 508.0.

Output: Descriptions of the existing legal structure, its shortcomings in relation to the future plan, and possible additions and/or changes to the structure.

520.0 - DEVELOP IMPROVEMENT PROGRAM

Purpose: To establish a priority program for constructing the required system by providing individual improvements in those links of the system where the growth rate of demand is greatest.

Dependencies: #510.0 and 511.0.

Output: A priority program of improvements that will adequately serve the forecast travel demand.

530.0 - REVIEW

Purpose: To allow the entire committee system to evaluate the proposed improvement program, to suggest alternatives, and finally to adopt a formal plan.

Dependencies: #520.0.

Output: A formal land use and transportation plan with recommended priorities, estimated costs and revenues, and suggested modifications of the legal structure.

601.0 - ORGANIZE CONTINUING STUDY

Purpose: To describe the need for a continuing planning process and to develop a scope of the continuing study.

Dependencies: #530.0.

Output: Modifications and additions to the continuing program established in the study design.

604.0 - FORMAL AGREEMENTS

Purpose: To establish a set of legal agreements among the participating agencies. Provide a basis for continuing financial contributions as well as a commitment to cooperate in the continuing planning process.

Dependencies: #601.0.

Output: The signed documents and any revisions to the continuing program. (This is often part of a regional planning commission.)

605.0 - COMMITTEE SELECTION

Purposes: To establish a policy, technical, and Citizens Advisory Committee that will provide the necessary guidance to the continuing planning process.

Dependencies: #604.0.

Output: The organized committee system with defined channels of communication, authority, and responsibilities.

606.0 - STAFFING PLAN

Purpose: To develop the most feasible staffing plan based on the experiences of the initial study and the continuing availability of local technicians.

Dependencies: #605.0, time commitments from local agencies, and a policy decision on the use of professional consultants.

Output: The staffing plan, including a prospectus for professional services if a consultant is to be retained.

610.0 - REVIEW FINANCIAL RESOURCES

Purpose: To obtain periodic trends in tax revenues and Federal Aid programs that concern the financing of transportation improvements.

Dependencies: #606.0.

Output: Periodic tabulations of tax revenues, Federal Aid allotments, and trends in legislation which concerns the transportation system.

612.0 - REVIEW GOALS AND OBJECTIVES

Purpose: To allow for periodic reappraisals of community efforts and re-evaluation of goals and objectives.

Dependencies: #606.0.

Output: Revisions in the structure of goals and objectives used to evaluate the adequacy of the transportation system.

614.0 - REVIEW TERMINAL REQUIREMENTS

Purpose: To allow for periodic reviews of the demand for terminals (i.e., downtown parking, airport terminal adequacy).

Dependencies: #606.0.

Output: Revised terminal estimate tabulations.

615.0 - REVIEW LAND USE PATTERNS

Purpose: To maintain a current listing of land uses and to develop trends in use changes.

Dependencies: #606.0.

Output: Updated land use data tabulated by zone.

616.0 - REVIEW ECONOMIC GROWTH

Purpose: To allow for periodic reviews of the growth of the Area and comparisons with forecast growth.

Dependencies: #606.0.

Output: Revised growth estimates, land requirements, and population.

617.0 - REVIEW TRAVEL PATTERNS

Purpose: To determine whether the travel habits, assumed to remain constant for model calibration, are changing over time.

Dependencies: #606.0.

Output: Revisions of trip generation characteristics and trip length relationships.

618.0 - REVIEW TRANSIT TRAVEL

Purpose: To determine the effects of transit on the entire transportation system and whether this effect is changing.

Dependencies: #606.0.

Output: Tabulations of transit characteristics relative to average trip length, passenger volumes, and type of passenger (children, adults, or the elderly).

619.0 - MONITOR TRAFFIC SYSTEM

Purpose: To maintain current estimates of street utilization, congestion, and accident experience; and to develop trends in volume, speed, and accident experience on the various types of streets in the system.

Dependencies: #606.0.

Output: Tabulations of volume, speed, and accident experience on each link of the street system.

622.0 - REVISE STANDARDS

Purpose: To adjust the standards of minimum acceptable street service to account for changes in the goals and objectives of the community.

Dependencies: #612.0.

Output: Revised standards for street utilization by functional classification.

625.0 - UPDATE LAND USE FORECAST

Purpose: To revise the land use forecast to reflect changes that were not anticipated in the original forecast.

Dependencies: #615.0 and 616.0.

Output: Revised land use plan.

627.0 - CHECK FORECAST MODELS

Purpose: To determine whether the calibrated models remain adequate with changing travel habits.

Dependencies: #617.0, 618, 0, and 619.0.

Output: Recalibrated models or the introduction of new models if the original model assumptions are no longer valid.

637.0 - EVALUATE PLAN ADEQUACY

Purpose: To determine whether changes in economic growth, land use, or travel demands require a change of the original plan.

Dependencies: #610.0, 614.0, 622.0, 625.0, and 627.0.

Output: Technically feasible plan revisions.

647.0 - REVIEW

Purpose: To allow the policy committee to select plan revisions if they consider such action appropriate.

Dependencies: #637.0.

Output: Revised land use and transportation plan.

690.0 - IMPROVEMENT DESIGNS AND PROGRAMMING

Purpose: To develop design plans and schedules for implementation of the planning proposals.

Dependencies: #530.0 or 647.0, and detailed physical inventory.

Output: Engineering designs for transportation system improvements.

